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Post Office telecommunications journal

Spring 1971 Vol. 23 No. 1

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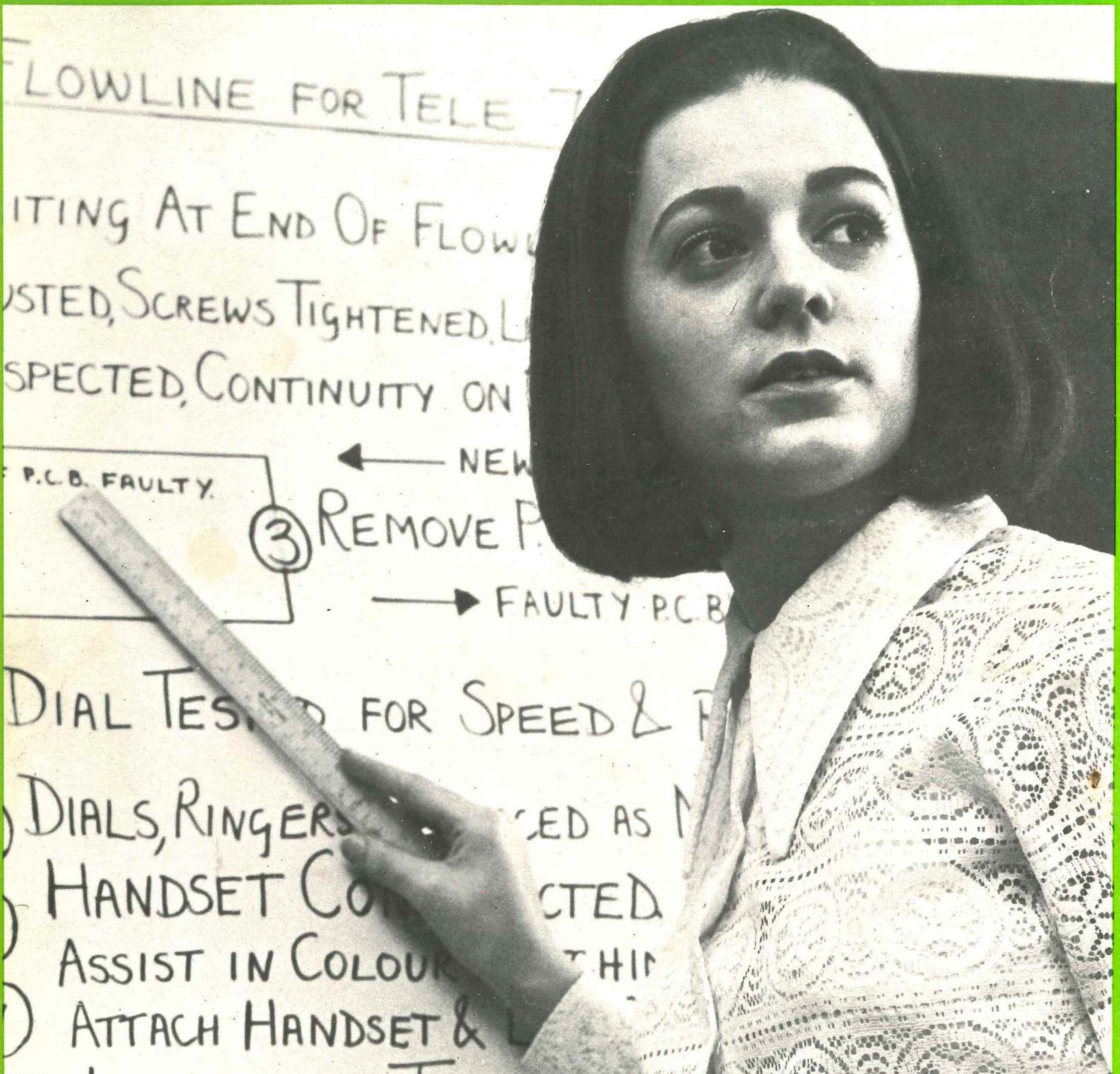
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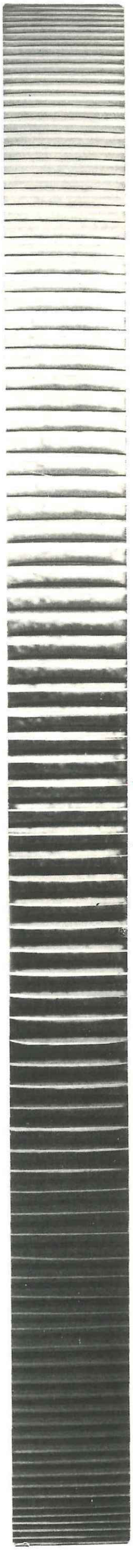

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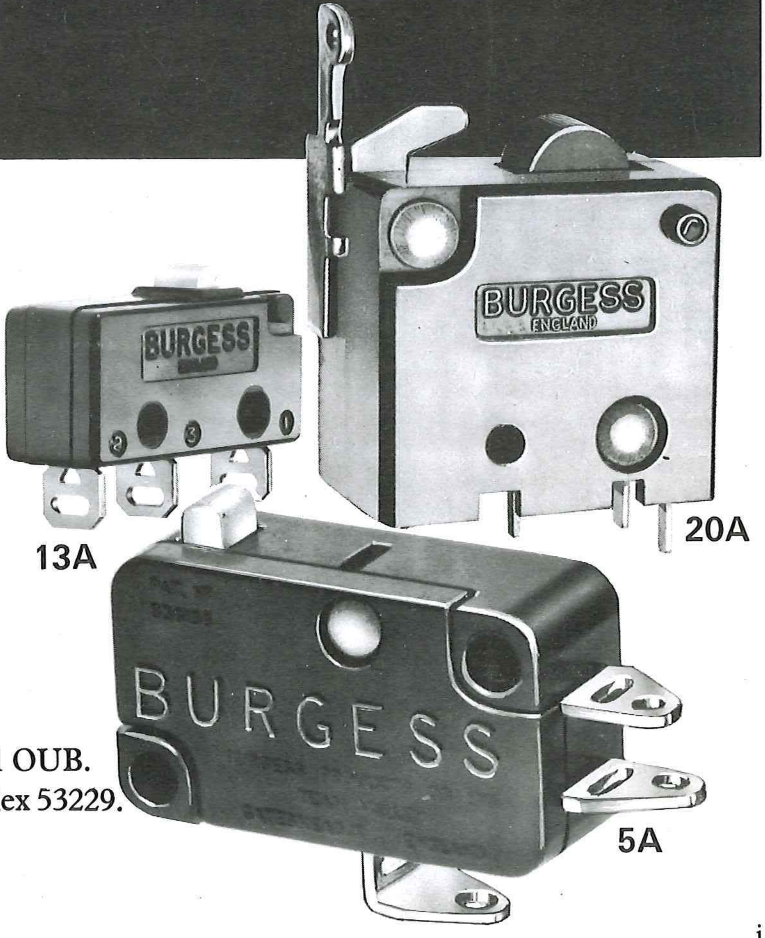

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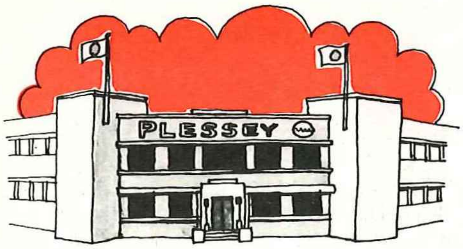

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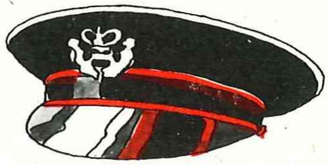

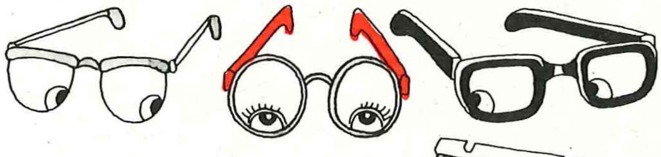

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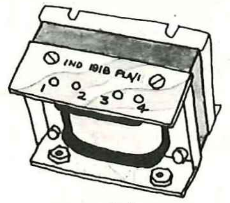

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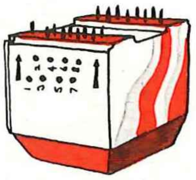

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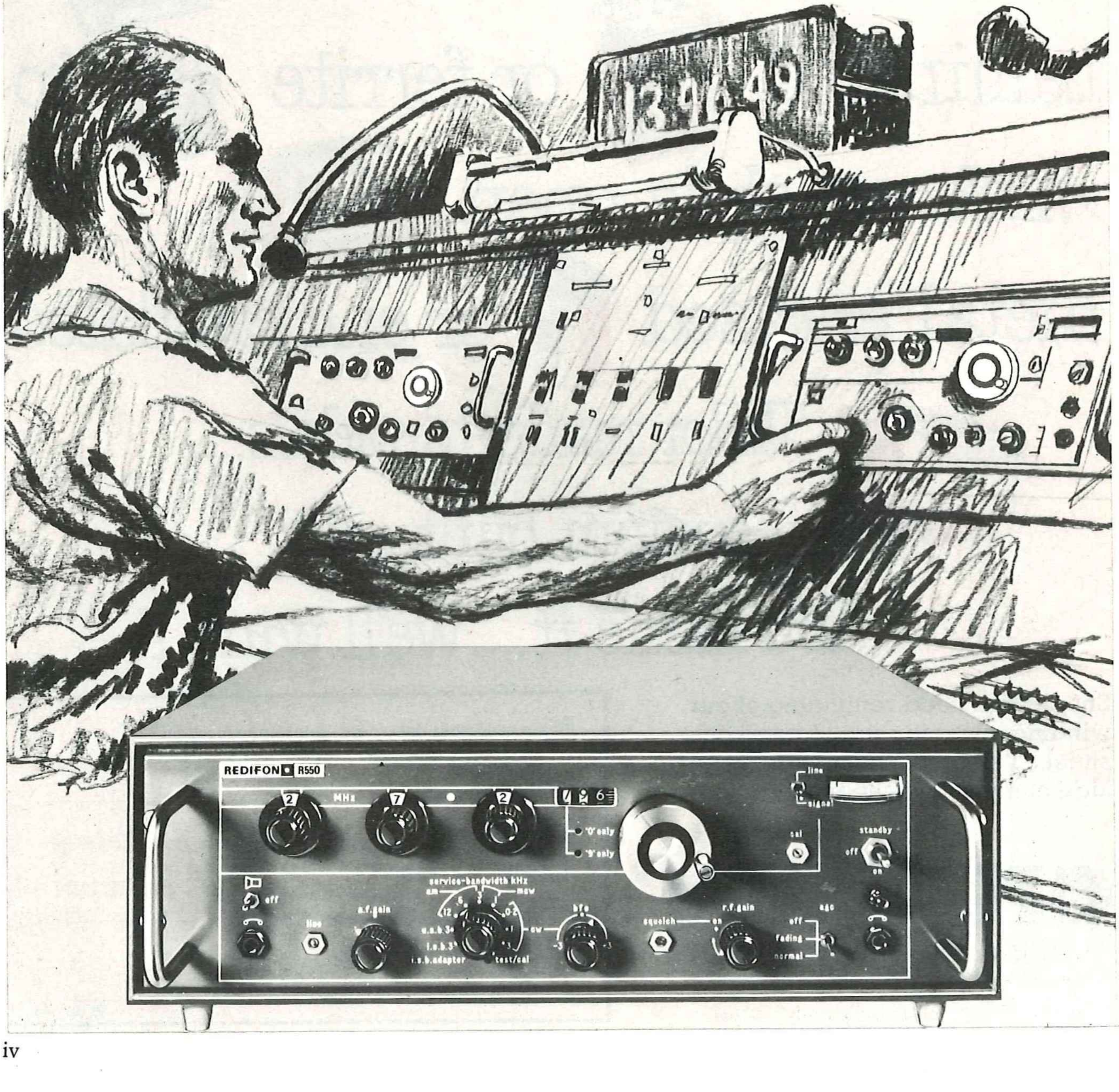
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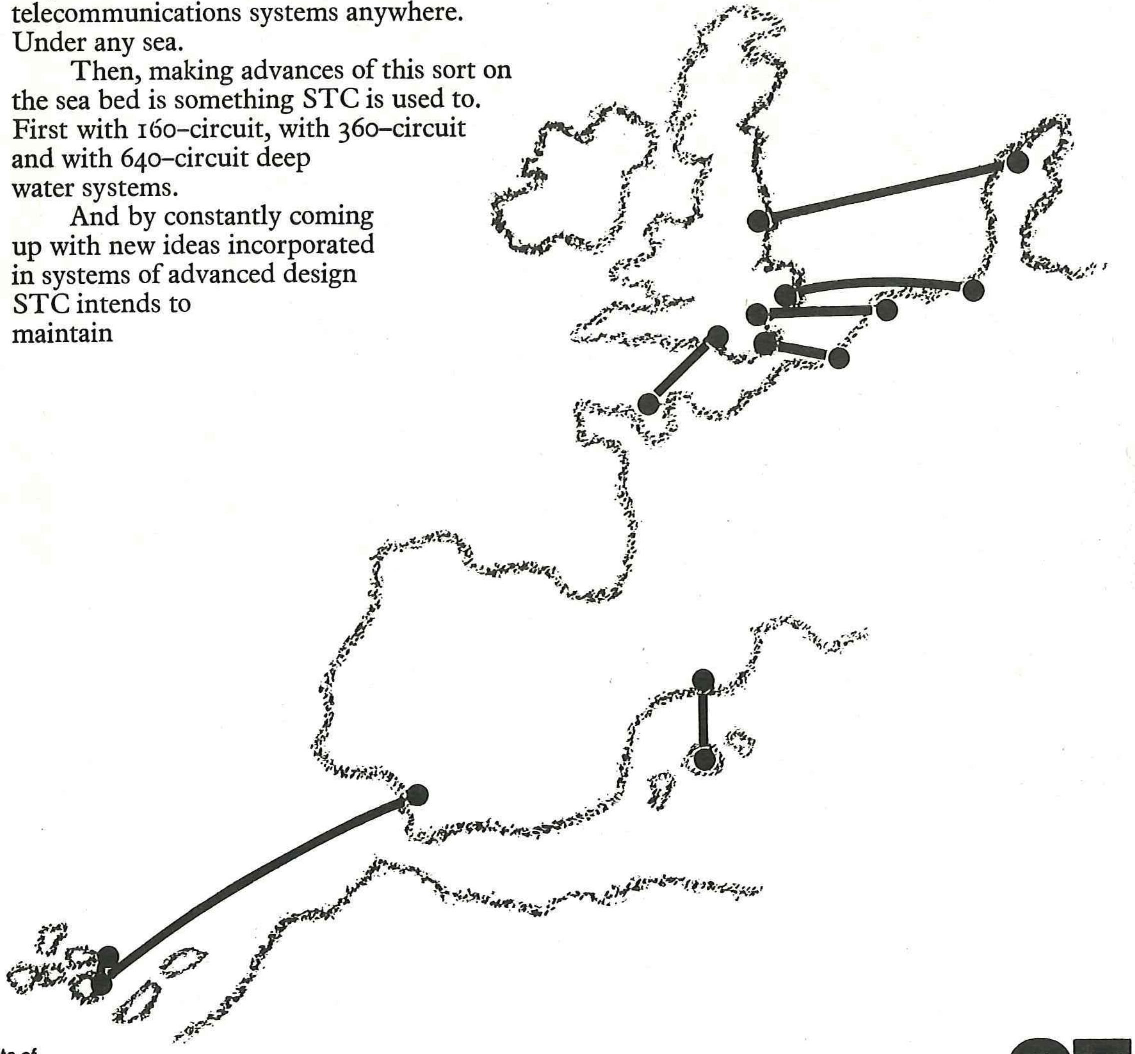

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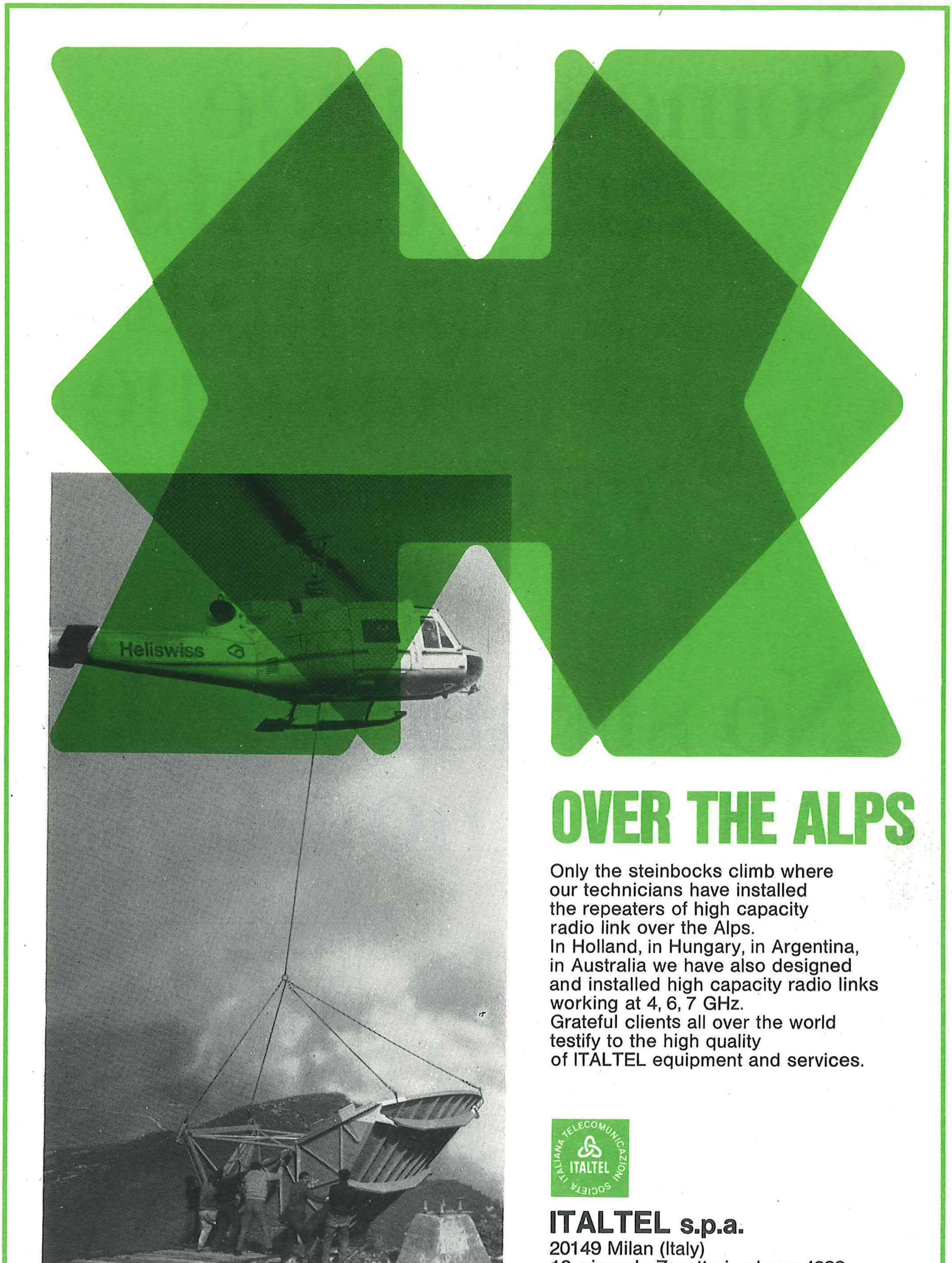

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Spring 1971 Vol. 23 No. 1

CORPORATE PLANNING IN THE POST OFFICE

Contents:
The computer age brings with it problems as well as advantages. The challenge for the Post Office provided by the huge growth in data communications is examined in an article beginning on page 8. Two other articles describe how the computer is being used as a maintenance aid in a telephone area (see page 13) and to organise the payroll of Post Office staff (page 26).

Also in this issue:

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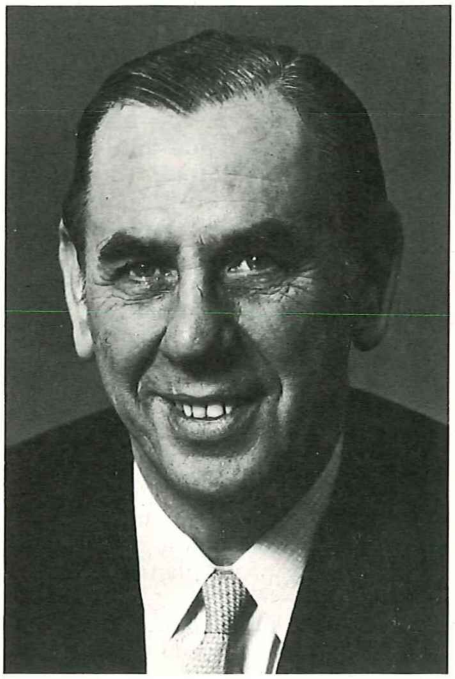
COVER PICTURE: Miss Clare King, who has joined the Post Office through the University Studentship Scheme (see page 6), explains a project in production engineering to senior engineers and education specialists visiting Birmingham Factories Training Centre. She undertook the project during initial pre-University training. Miss King is now in her first year at Southampton University reading electronic engineering.


Mr. A. W. C. Ryland

In his recent lecture to the Institution of Electrical Engineers, Mr. A.W.C. Ryland discussed the controls and restrictions which government places on the Post Office and other nationalised industries. Mr. Ryland, Acting Chairman and Chief Executive of the Post Office, highlighted the conflicting requirements of government supervision and vitality of management: the extent to which state industries need to be independent to function effectively and efficiently, and how this cannot be reconciled with the accountability expected by government.
His solution to this dilemma was based on the concept of corporate planning – "the sensible and responsible way of running large organisations". This extract from the lecture – in which Mr. Ryland emphasised he was speaking personally and not on behalf of Post Office colleagues – is the final section dealing in detail with corporate planning. Mr. Ryland explained that the idea followed lines being developed by Sir Henry Benson in consultation with the Coal and Steel industries and government officials.

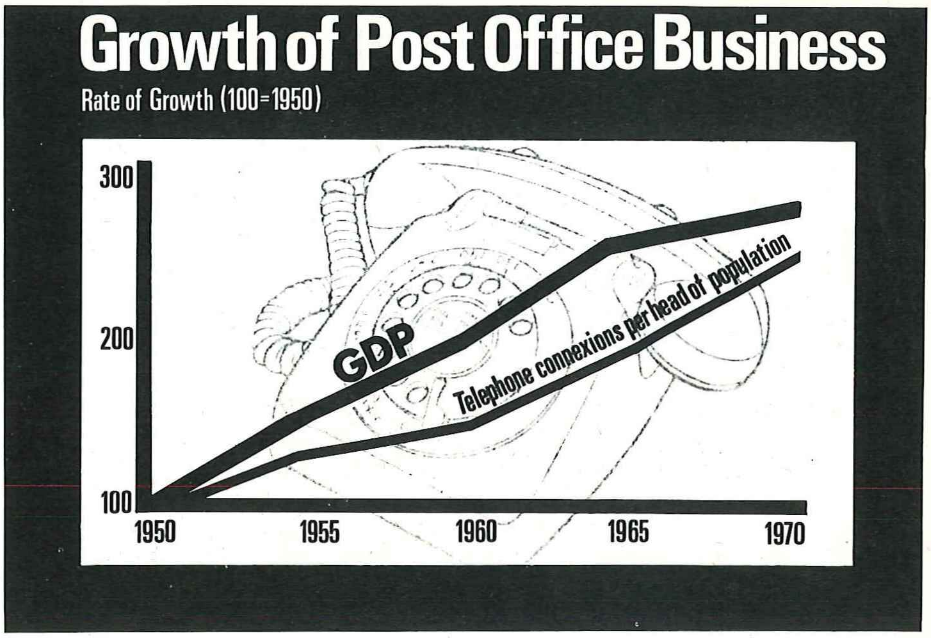
“Corporate planning has become generally accepted in America, in this country and in many other advanced industrial nations as the sensible and responsible way of running large organisations.

In the Post Office we are going for corporate planning hook, line and sinker. If this provides us with the best way of running the ubiquitous business for which we are responsible, surely it can be adapted to take account of the essential needs of government in controlling us. What is more, if it can be used by government for the supervision of the Post Office and if it is acceptable for the Coal and Steel industries, it can surely be used for the supervision of state industries generally.

Let me be a little more precise. The essentials of the system—in our case at any rate—are five documents of primary importance:

First, there is the long-term corporate plan. This aims to sketch in broad terms the development of our industry over an 11-year period. It provides the guidelines within which we intend to work.

Secondly, there is the rolling five-year investment programme (pro-



Mr. Ryland said the Post Office today was big and busy. Growing fast and changing rapidly. He used this graph to compare the growth in telephone connexions with the Gross Domestic Product and continued: "The telecommunications business is technology-based and investing at the rate of £1000 a minute, day and night . . . investment which is increasing at a greater rate than that of any other organisation in the country. It has vast fixed assets exceeded only by Shell and the Electricity Supply Industry. It is doubling itself every five to seven years . . . and is striving to keep pace with the change and complexity of present-day technologies."

duced annually) prepared very largely as now. This shows distribution of resources and includes the assumptions of business growth, new service, modernisation, capital expenditure and so on.

Thirdly, there is an annual operating programme. This sets out the short-term budgets, targets and relevant performance indicators for the year ahead in broad sectors of the business. They are the end results of targets set for, and accepted at, all management levels throughout the organisation.

Fourthly, there are periodic reviews of how we are doing against budget, target and the relevant indicators, and what, if any, remedial action is necessary.

Finally, there is the Annual Report and Accounts, audited by independent professional auditors and presented to Parliament each year.

The totality of the plan, considered and approved by the Board, forms a blue-print for the Post Office in the short, medium and long terms. The amount of detail in the plan varies from section to section and depends largely on the differing time-scales involved. It hinges on various indicators and targets, and it is these which could be of importance to government, in the supervision of our plans, programmes and performance. They would be the key to the development of the Post Office.

As the plans and programmes are drawn up each year the relevant parts would be agreed with government. At that stage they would probe and examine so as to satisfy themselves on the general soundness of the Board's proposals and the effectiveness and efficiency of its planning and its management.

Once the key factors had been identified and agreed, government would receive reports on progress and performance and would be advised in good time of adverse trends and the action being taken to correct them.

I believe—and here let me re-emphasise that I am speaking purely personally—that a scheme on these lines would remove many of our difficulties. There would be agreement in advance on the areas of legitimate government interest and supervision over the work of the industry. There would be an understanding that the management of the industry would be a matter for the Board, provided it did its job. The monitoring reports would show whether this was so. And if it wasn't, the Government has many powerful weapons in its arsenal. The power of sacking—or should I say firing—is the ultimate power.

There would have to be a self-denying ordinance. No system could be expected to work well without one. In this case it would amount simply to an acceptance of the fact that, once the plans had been agreed, the Ministry would not probe and ask for much and varied information, deploying their requests to all sorts of people at all sorts of levels in the industry.

Naturally there would be a need for supplementary, or unpredicted, information and reports from time to time. These however would be requested and returned through the Board Members responsible, on the Post Office side, and comparable levels in government. These would be the people involved in the corporate planning discussions and together they could ensure that supplementary demands were relevant, minimal and reasonable.

This then is the germ of an idea. As I have already said it is not a new idea. I put it forward tonight because in my view it is the only idea which is really workable. The only idea which reconciles the rights and obligations of government with the needs and responsibilities of the industry in a way best calculated to serve the primary objectives of customer satisfaction, staff satisfaction and profit without which a state industry will fail sooner or later.

It is sufficiently flexible to take account of all the main variations that can occur. So long as the principle is accepted and there is understanding all round there need be no rigid rules to be applied immutably year after year. But there is one very desirable pre-condition, and that is that the principles should be accepted by both the main political parties so that the whole concept—as distinct from the way in which it is applied—can be expected to endure when governments change . . .

LECTURE QUOTE

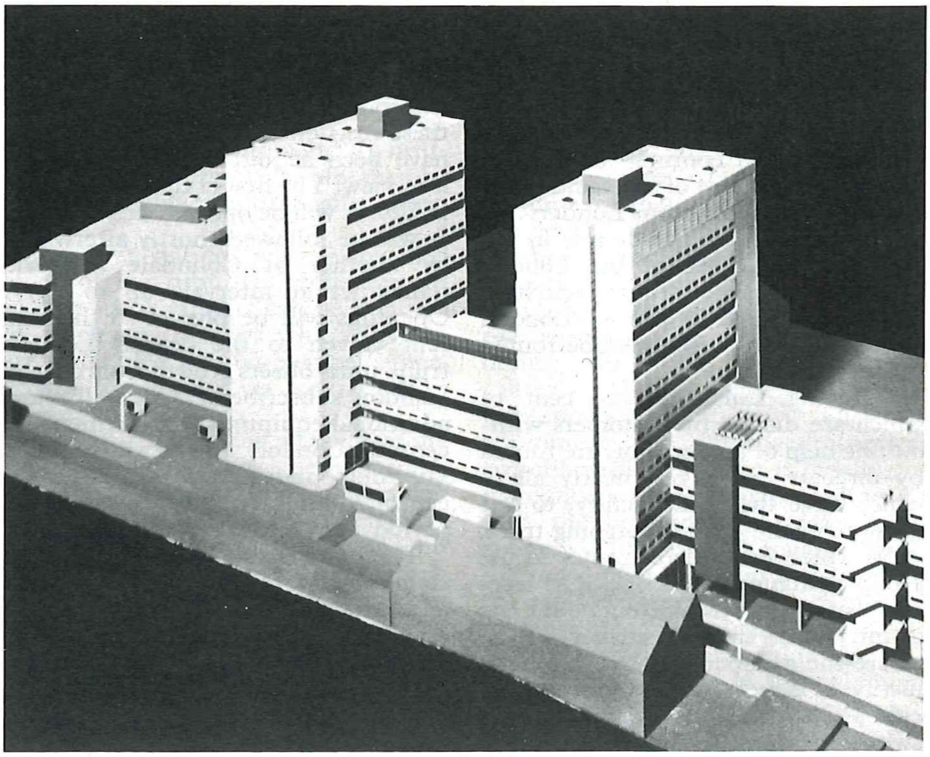
"The Post Office and other main state industries are cardinal to the infrastructure of the country. They are big business. They must be responsive, thrustful, venturesome, efficient and—what is not quite the same thing but equally important—effective.

"However, this desirable state cannot be achieved unless the people responsible for running those industries have freedom to act; to succeed and be praised, or to fail and be damned. If they have to divert their attention to deal with constant investigation, interrogation and examination they will not be able to do the job for which they were appointed.

"The problem is that the Post Office needs an independence and freedom which the shareholder—the nation, and, on its behalf, Parliament—cannot reasonably be expected to give without some form of accountability. The tendency is for that accountability to be so pervasive as to negate or blur the independent management of the industry.

"At the same time we must not dilute in any way the responsibility of state boards to government. They after all are charged with running a slice of the nation's business and the nation's business is the government's business."

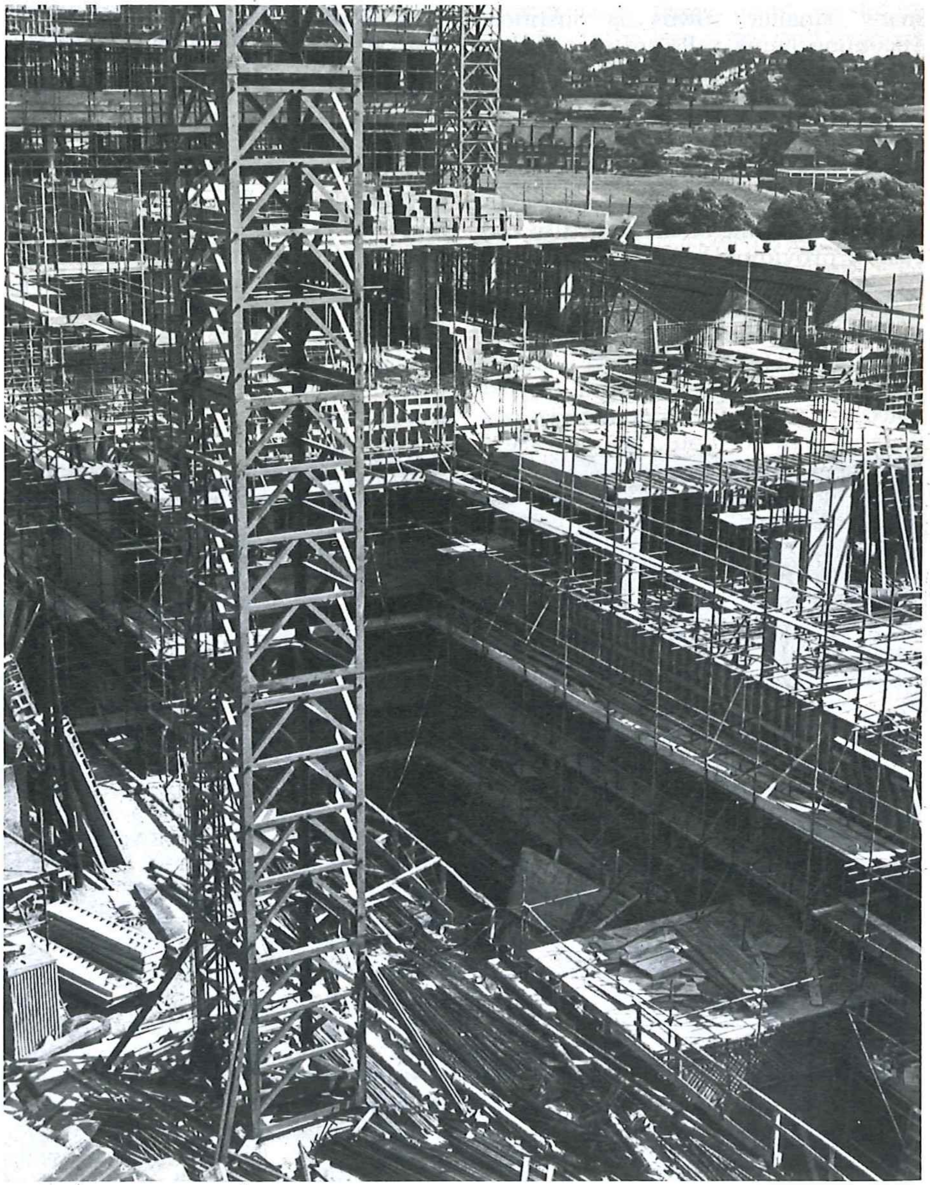
A vast expansion programme is under way to reshape the whole of London's trunk switching arrangements. New telephone trunk centres are being set up to deal with trunk traffic in seven suburban sectors of the London director area



New era for trunk switching in London

J F Birt

Construction work pushes ahead on the new Telephone Trunk Centre for Colindale, in London's North West Area, which will be one of the first to be opened. Above: a scale model of the new Centre as it will look when completed.



LONDON trunk switching arrangements have been evolving continuously since the last war, both to improve the trunk service and to meet the increasing demand. Progressively, automatic working has been introduced. First came trunk mechanisation which enabled a single operator to complete connexions; later the local dialling range was extended when group charging was introduced and more recently there has been the introduction of STD to permit subscribers to dial their own trunk calls.

In the early post-war period central London trunk units served not only London subscribers but also served as the Zone Switching Centre for the whole of the South-East corner of the United Kingdom. With the growth of trunk calls the numbers being switched in central London began to give concern and it was decided that, to reduce the size of the London zone, three new Zone Switching Centres should be created at Tunbridge Wells, Cambridge and Reading. These are now in existence and soon the only inland trunk calls to be switched in London will be those originating from or made to London director exchanges.

Even so, the trunk calls switched in central London continue to rise. At present, 20 per cent of all inland trunk calls are originated from London and demand is expected to double in the next five years. All of the London director exchange trunk switching units are located in central London so that all trunk calls must be routed via this area.

Outgoing calls, 90 per cent of which are dialled by customers without the help of an operator, are routed by director exchanges, nearly all of which have the STD facility, to one or more of the central outgoing trunk units which have direct routes to the group switching centres (GSCs) serving large towns throughout the country. For calls to smaller GSCs, where the number is not sufficient to justify a direct route, the calls are either switched via distant group switching centres or through the London Kingsway unit. By concentrating calls from all the London outgoing trunk units through Kingsway a collective London route to many smaller towns is justified. Incoming trunk calls are switched at the central incoming trunk units which mostly have routes to every director exchange. The next step is to decentralise some of this switching equipment by establishing seven telephone trunk centres in the suburbs so relieving some of the difficulty and cost of providing buildings in central London.

The outline for the new plan was produced by the London Trunk and Junction Network Task Force—whose final report was published in August 1965. Its principal recommendations were that there should be a measure of decentralisation of trunk and tandem switching units, the existing central London units being retained with some change of function but supplemented and relieved by seven telephone trunk centres located about eight or nine miles from Central London.

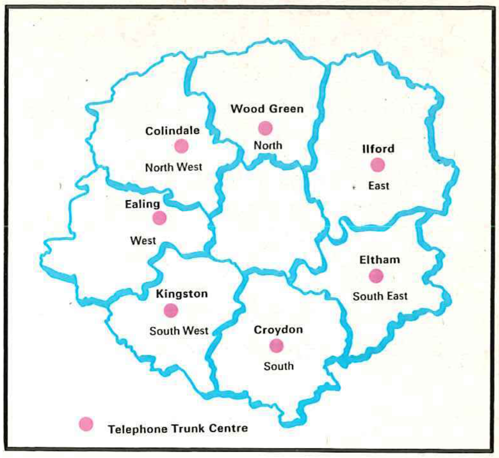
The recommendations were accepted and in May 1966 a working party was set up at London Telecommunications Region headquarters to implement the plan. The upsurge of telephone calls, particularly of trunk calls, made it imperative that the plan be implemented as quickly as possible before congestion in central London became so acute that redeployment of plant would become too difficult. But sites had to be found, buildings erected, equipment installed and new cables laid.

Finding suitable sites has not been easy. A site needs to be of two to three acres and the required location is closely dictated by the need for the switching plant to be close to the theoretical traffic centre for the exchanges it serves. It must preferably be easily accessible from existing cable and duct routes and with public transport nearby for staff. Despite these restrictions six of the seven sites have been acquired and the seventh is in view. The first of the new centres, at Ilford, will be opened early in 1973. It will be followed shortly afterwards by another at Colindale and the remainder at intervals up to 1977. Openings will be phased so that the relief given to the central London trunk units offsets growth from central London subscribers. This will allow additional equipment requirements in central London to be kept to a minimum and resources to be concentrated on the new centres over the period 1973-77.

The boundaries of the seven sectors served by the telephone trunk centres and those of the outer Telephone Areas have been made to coincide so far as the director area is concerned. Management and service advantages will result because Telephone Managers will be more directly responsible for handling calls originated by their own customers. The trunk service in particular will be improved by the better transmission and faster and more reliable connexion which the plan affords. Cable costs will be less than would otherwise have been incurred to carry the growing number of suburban calls, because the junction circuits between the sector director exchanges and the telephone trunk centres serving them are shorter than those to central London. This will also permit the use of less expensive junction cables with lighter gauge conductors.

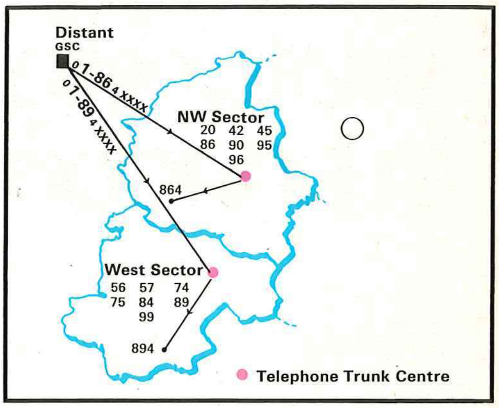
Trunk calls from subscribers connected to exchanges within the sectors will be routed via their respective trunk centre where switching equipment will be of advanced design; crossbar (TXK 1) with stored programme control (SPC) of the register-translators—the first of its kind. This equipment will control the routing of calls to their destinations and automatically levy the appropriate charge, as do the register-translators in the central London units. The suburban trunk centres will therefore have their own direct routes to group switching centres serving large towns. These routes will carry the bulk of the trunk calls, the residual being routed via a Special Purpose Unit/Main Switching Centre (SPU/MSC) in central London to be housed in Colombo House, the new building, adjacent to Waterloo exchange.

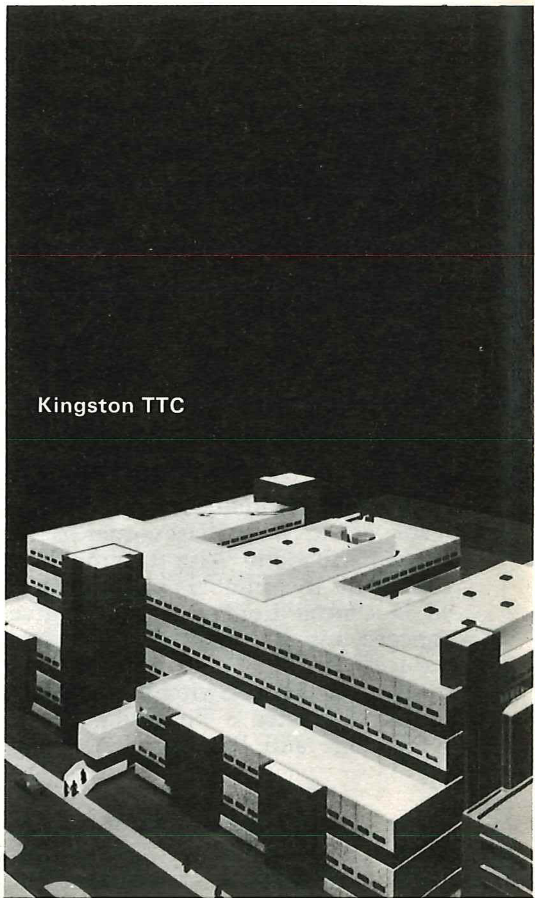
The SPU/MSC unit will have four-wire switching equipment with fast signalling which will give fast and more reliable connexion through the unit to and from distant group switching centres; the transmission on calls via the SPU will be as good as that obtained on those routed over direct routes between distant group switching centres and the suburban



This map of the London director (01) area shows the divisions facilitating the new trunk switching and routing plans. The boundaries of the sectors coincide with those of the outer Telephone Areas.

Below: two sectors of the director (01) area showing the first two digits of the All Figure Numbering codes allocated within each sector.

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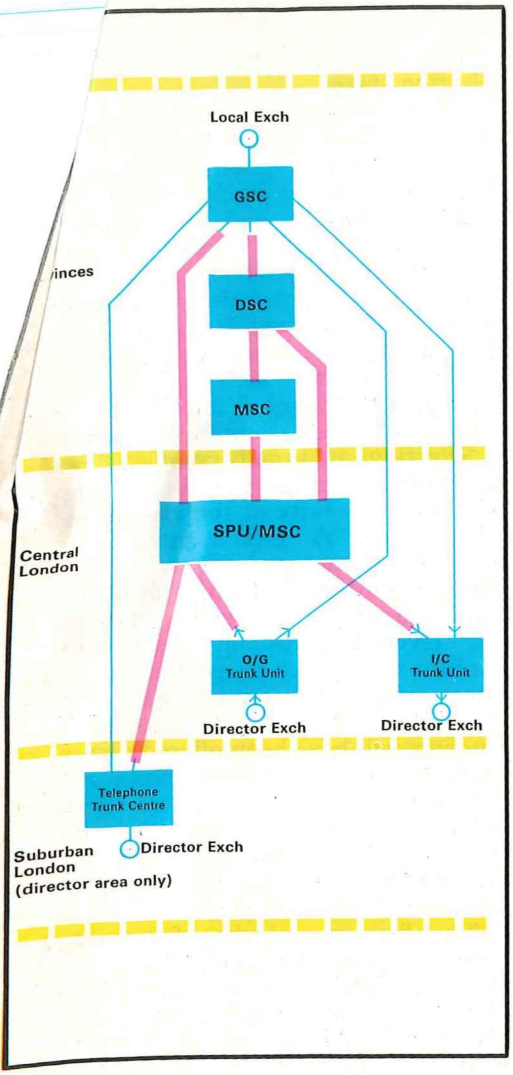


The diagram shows how London's trunk calls will be routed when the Sector plan is complete. The red lines denote four-wire switched circuits.

or the central London units.

A feature of the SPU/MSC will be high-usage working between London and distant towns whereby, at peak periods, calls will automatically overflow to an alternative route thereby increasing efficiency of smaller direct routes.

Repeater stations will be installed in all of the suburban trunk centres so that trunk circuits can be bundled in 12-channel groups which in turn are assembled into 60-channel supergroups for routing via coaxial cables or radio links.

By about 1977 when all seven of the suburban centres have been opened, the central London units—which will then serve central London exchanges only—will also use the SPU/MSC so that the economic advantage of high usage routes and the benefits of improved transmission and switching on indirectly routed calls are available to all London subscribers.

In order to route trunk calls direct to the suburban telephone trunk centres from distant group switching centres, calls for each sector must be identified and appropriately routed by the originating register translator equipment at the distant end. The change-over to all-figure numbering (AFN) in the London director area facilitates this and the exchange numbers are so arranged that the first two digits identify the sector in which the exchange is located.

For local calls to and from exchanges in the charging groups adjacent to the London director area, direct routes will be provided between the suburban centres and all of the adjacent group switching centres around London so that routing of sector traffic via the central toll uni will be avoided and the central tc units confined to serving exchange in the four central Telephone Areas

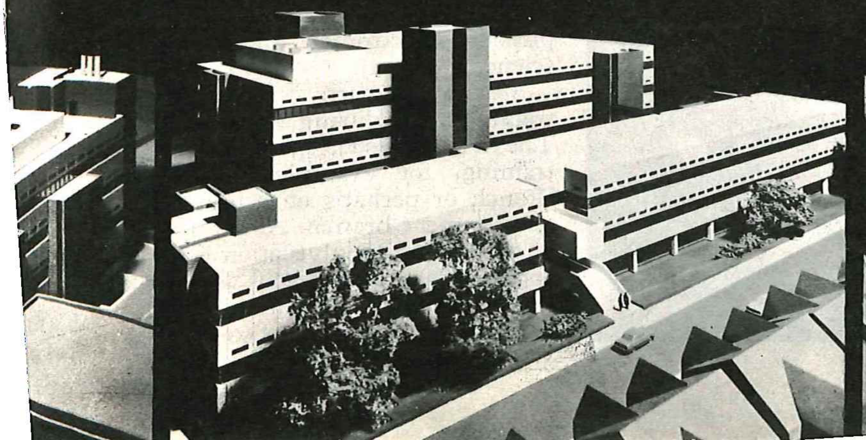
Each of the suburban centres wi house a tandem exchange for routin within-director-area calls. Ultimatel the centres will also house one, tw or three automanual centres, each separate managerial unit of 9 positions. The switchboards will be the cordless type of an improved design which will permit the advantages of the keysender to be utilised more effectively. The new equipment and improved cordless switchboards will make it possible to introduce a range of new facilities to help the operator and make faster connexion possible. These are outside the scope of the present article as are the revised routing arrangements for within-director-area calls.

The sector plan heralds the approach of a new era in the switching and routing of London's telephone traffic. Despite the relief to the central London units which this vast expansion programme will give, further trunk units will still be required in central London. Two further large trunk units are to be opened in the late 1970s and negotiations for sites and preliminary planning are well in hand. One will be at North Paddington and the other in Queen Victoria Street in the City of London.

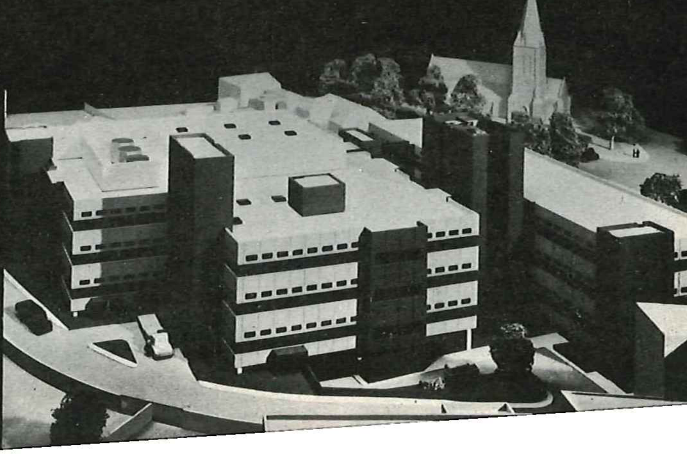
Mr. J. F. Birt, who joined the Post Office in 1941 in London, subsequently served in Newcastle-upon-Tyne and Middlesbrough and as a training officer at the Headquarter's Traffic Training School. He is now temporary CTS in the Trunk Planning Branch of LTR.

The models, pictured here, show how the Kingston, Ealing and Wood Green Telephone Trunk Centres will appear when building work is completed. Because of the size of the buildings, preparatory work on all the sites is a big job, but at the Wood Green Centre it has been exceptional. The Centre is sited almost directly above the tunnel carrying the Piccadilly Line tube trains, and this has meant extra piling work to support the surrounding ground. It is also a tricky civil engineering job because pilings have to be driven to within 17 ft of the tube tunnel. Excavation work has had to extend over almost all the site. About 95,000 tons of soil will be removed leaving a giant crater 41 ft deep. Eight hundred tons of sheet piling will be used, driven down 51 ft.

Ealing TTC



Wood Green TTC



Post Office students scheme looks for...

young people with talent

J B Millar/
A E Stokes

MOST industrial and commercial organisations look to the Universities for a proportion of their recruits to management and professional posts. In this respect the Post Office is well served, and substantial numbers of graduates are recruited each year for training in a wide variety of jobs in the businesses.

Many organisations, including the Post Office, go a stage further. They recruit school leavers of high professional potential and integrate their industrial training and academic work in studentship schemes of one form or another.

The Post Office instituted its own scheme for University Studentships in Engineering and Science just over 10 years ago. The "Post Office Student"—up to 1968 the title was "Student Apprentice"—undergoes 12 months of special training within the Post Office, followed by a three or four years honours course at University. For as long as they are associated with the scheme students receive a salary ranging from £400 at age 17 to a maximum of £800.

The number of studentships offered each year is related to the total engineering and scientific graduate recruitment requirements, bearing in mind that students will not be available to fill posts for some four to five years. At the start of the scheme 20 awards were made. In 1970 a peak of 47 students were recruited. Generally, the number of candidates invited for interview is three to five times the number of studentships being awarded.

Each October applications come from students in their final "A" level (or "H" grade in Scotland) year in response to publicity directed at schools with science sixth forms. Applications are submitted via heads who add their assessment of each candidate's potential, and this proves of great value in the subsequent selection stages.

Since 1969 the selection procedure has comprised a number of written tests and two interviews. The tests are designed to assess intelligence, aptitude for scientific and technological work and, to some extent, personal qualities. Two assessors interview independently, one being concerned mainly with a candidate's personal qualities and the other with qualities of intellect and ability to apply academically acquired knowledge to engineering and scientific activities.

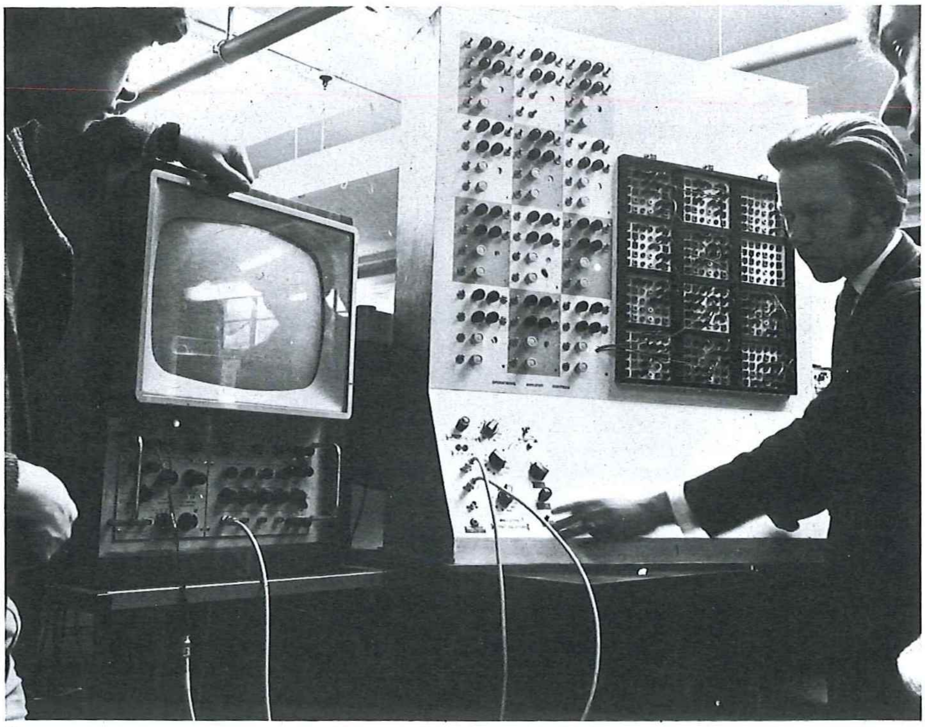
Selections are usually completed by the end of February of the year in which the majority of the candidates will sit their "A" level examinations, so offers of studentships are usually made conditional upon candidates achieving an acceptable standard at "A" level. It is usually possible to confirm a very high proportion of the offers after "A" level results are released in August. By this time students will have been offered places at the Universities of their choice and will have to ask for the places to be deferred for a year. This raises no problems; in fact many Universities are convinced of the value of a pre-University industrial year.

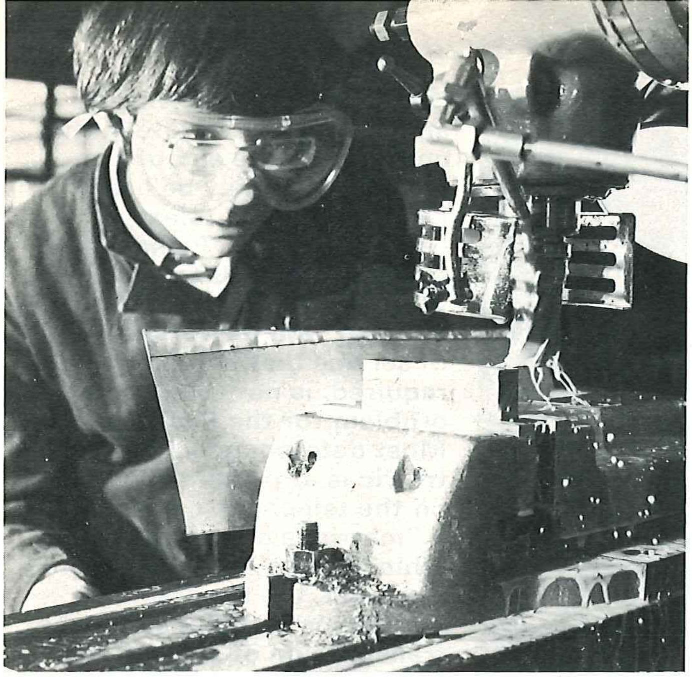
The first 12 months of training within the Post Office includes workshop practice at West Oxfordshire Technical College and Birmingham Factory Training Centre designed to satisfy the requirements of the professional institutions of which most students will later seek membership. There is also Area training which introduces many aspects of the telecommunications technology in an environment which emphasises the customer-service nature of our activities. At intervals during Area training students attend the Post Office College of Engineering Studies, Horwood House, near Bletchley, Bucks., for intensive two-week academic courses covering maths, physics and electronics, including practical work in a well equipped laboratory. Much of this work is of first-year University standard and beyond, and prevents any falling off of academic capability during the break between school and university.

On completion of their 12 months training students go up to their Universities for honours courses which include electrical, electronic and mechanical engineering, maths, physics, electronics and computer science.

Students return to Post Office training only during long vacations. The first of these is spent on specialist training, for example in Research Branch or perhaps on a project in a development branch. About a month of the second long vacation is usually spent with a continental administration studying telecommunications practices. Students have so far visited

Part of the analogue computer which has been built up by successive generations of Post Office Students in the laboratory at Horwood House. The oscilloscope on the left is being used to give a visual display of the operations of the computer.





France, Belgium, Holland, Germany and the Scandinavian countries.

By the third year most students have an idea of the work they want to do after graduating. To assist them, a conference is held during their last Christmas vacation when representatives of various Post Office departments, usually at Deputy Director level, describe the work in their part of the organisation and help students to narrow their choice. Later, students can visit the sections which most interest them and, as a rule, by final examination time they have reached a firm conclusion on jobs for which they are suitable and to which they wish to be assigned.

After graduating students are normally regraded Executive Engineer or Scientific Officer depending on the type of work, and their final year of specialist training which completes the "sandwich" is undertaken in the new grade.

The scheme is popular and, with a large number of very able applicants, the Post Office can award the limited number of studentships to young people of high academic ability and proven technological interest who are likely to make very rapid progress in professional work after graduation.

Experience so far has shown that people have benefited from this scheme, both in acquiring a deeper understanding of their academic work in relation to its application (with a resulting very high standard of attainment in degree examinations) and in becoming effective very quickly indeed in their first professional level appointments.

Mr. J. B. Millar, an Assistant Staff Engineer in Post Office Appointments Centre, is in charge of the Studentship selections. He was previously concerned with radio systems, PCM and closed-circuit TV for schools.

Mr. A. E. Stokes, a Senior Executive Engineer, is concerned with the training of the students at Horwood House. He has been involved in the development of the Studentship scheme since its early days.

Above, left: a student uses a milling machine to carry out a facing operation on a piece of metal.

Above, right: the metal workshop at West Oxfordshire Technical College which is equipped for both machining and bench work.

Below: a student works on an investigation into the possibilities of designing a "cordless" telephone.

Computer room

DATA COMMUNICATION -CHALLENGE FOR THE SEVENTIES

M A Smith

Data Terminal

DATA traffic is growing at an unprecedented rate in this country. By the end of the decade there may be half a million data and telex terminals in use. Planning the best methods to cope with this huge increase in demand, and the various types of service that will be required, is now a major problem for the Post Office. Most data-communications traffic is at present carried on the telephone network, a "marriage of convenience" which has so far served well. However, the telephone network was designed for the transmission of speech, and equipment has had to be devised to convert data signals to the speech bandwidth. Traffic characteristics are also different. Where an effective telephone call may last only three minutes, a data call from a remote terminal to a computer bureau may last for more than 20 minutes. On the other hand "enquiry-and-response" data terminals, such as those used by airlines for seat reservation, often need to establish a connexion to the central filing-system processor, send a message and receive a reply within a few seconds.

These and other factors have focussed attention in many countries on the need to study data communications as a distinct public service. A special working party of the CCITT—the international body dealing with telecommunications standards—recently met to consider new data-communications systems. To determine the most suitable type of data system for this country the Post Office has been carrying out intensive market and technical studies with the help of the business world and the telecommunications and computer industries. As a result certain lines of thought are now being put forward for consideration. This article reports on these emerging themes and takes a look back at the way data communications have evolved over a number of years.

DATA communication by electrical means really started more than 100 years ago when the Post Office established a network of telegraph circuits which were used for transmission of business data such as Stock Exchange prices and instructions for money transfers. For many years telegraph line plant was separate from telephone plant, and it is still possible to see footway boxes in the City of London marked "Post Office Telegraphs". The Telegraph system was progressively extended and improved, and in 1932 the PO Teleprinter No. 7 was introduced. This type of teleprinter was eventually to be used as one of the first computer data terminals, designers recognising that it could readily produce punched paper tape for input to the machine, and display output data as printed characters in page form.

In 1960 Automatic Telex was introduced and in ten years has grown to more than 30,000 stations. This system uses a switching method known as circuit switching where a fixed transmission-rate path is established between two teleprinters for the duration of the "call". Automatic Telex has also been used for data transmission at the rate of 50 Bauds (Bauds represent "modulations per second" e.g. the system can transmit 50 voltage changes per second).

It was apparent that specialised facilities exclusively for data transmission could not be justified until the scale and nature of demand had been defined, so the telephone would be used for most data-transmission purposes. This led to the introduction of modems (MODulator-DEModulators) which convert electrical data signals to and from signals which can be handled by the telephone network. The modems together with the telephone network mainly comprise the Datel services as we know them today, and will remain the mainstay of public data-communications services for many years.

The traditional method of handling telegraphic traffic is by message. At the accepting office the message exists as "hard copy" i.e. printed or written text, and is placed in a queue for eventual transmission by the most direct available circuit. During the past 20 years there have been various technical approaches to message switching, and fully electronic message switching systems have recently been developed. At the present time the switching costs per line are rather higher than those of electromechanical circuit switching exchanges. For this reason electronic message switching systems are often associated with very expensive long-distance international circuits because they can offer economic advantages in line utilisation which more than offset the switching costs. Another advantage of message switching is the increase in reliability of delivery, due to temporary storage of messages in transit and retransmission on an alternative route in the event of failure of the normal route.

This feature was used in proposals made by a Rand Corporation study team to the US Air Force in 1964 for a distributed switching node communications network. In these proposals the loss of one or more switching nodes would not disable the network. Unlike telegraph message switching systems, high-rate transmission facilities were to be used with very short queues at the switching nodes, permitting rapid handling of the messages or "packets" of data. This was dubbed the "hot potato" method. Work has continued on packet switching for data handling purposes in the USA at the Advanced Research Projects Agency (ARPA) and a network of high-rate transmission links connected to computers via message/packet processors is now in operation.

A similar approach for handling data was also devised a few years ago at the National Physical Laboratory (NPL). The NPL proposal was for a national network of switching nodes interconnected by a "high-level" or main network of high-rate digital transmission links, with access to the nodes via digital multiplexers in a "low-level" or local network.

In 1968 the Post Office decided to intensify its market and technical study activities in the field of data communications. As a first step towards forecasting future demand a market study contract was placed with Scientific Control Systems (SCICON). A summary of the results was published by the Post Office early in 1970 ("Data Transmission Surveyed").

At present we think there may be 500,000 data and telex terminals in the UK by 1980. This may not be a large number when compared with perhaps 17 million telephone connexions at that time, or even when compared with the 700,000 telephone connexions of 60 years ago. But in spite of the flexibility and universality of the telephone services it is appreciated that there are inherent limitations in adapting telephone circuits for some forms of data transmission that may arise. For example, it is assumed that customers will generally provide their own terminal data processing equipment which is unlike the present way in which telephone and telegraph switched services are provided. Again, because of the diversity of the requirements, it may be necessary to offer what effectively may be several functionally separate services to handle all of the different kinds of traffic. For example, telex traffic will require a capability for selection of the destination and the return of service signals in International Alphabet No. 2 which is the code currently used by all telex machines. New data-communications services would require to be functionally distinct from the present telephone service, although for economic reasons it would have to be physically integrated with it, e.g. sharing local and long-distance line transmission facilities wherever possible.

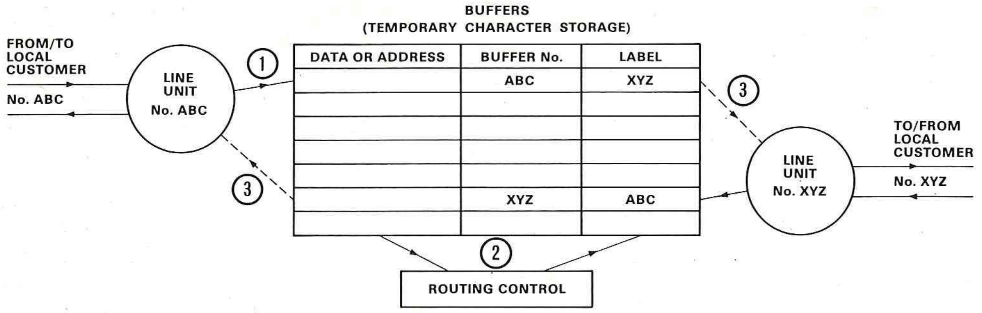
The intensification of technical study effort was partly achieved by study contracts placed with the telecommunications and computer industries. The objectives were to produce system design proposals for new data-communications services, and incorporating telex, that would show an overall economic advantage for remote data processing and other classes of data-communications users.

An interim statement on the studies was prepared in mid-1970 and tabled at discussions on international compatibility which have been held in London and Geneva, under the aegis of CEPT (European Conference of Posts and Telecommunications Administrations) and CCITT (International Consultative Committee on Telegraphy and Telephony). Post Office delegates presented the proposals which had emerged from the system studies. A series of Seminars with potential users were held in late 1970 to obtain their reaction to the proposals.

The results of the technical studies are still being evaluated, but two main conclusions were apparent at the interim stage. They are (a) full advantage should be taken of the technical and economic advantages of high-capacity digital transmission systems (often called PCM transmission since their initial use has been for telephony transmission by pulse code modulation) and (b) the data switching exchanges (DSEs) should be able to handle both packet and circuit switching by stored program control (SPC). Stored program control is preferred to a wired program system so that control sequences for operations like call establishment and routing can be held in a form which can be modified without making wiring alterations. This conclusion recognises that data services may require considerable operational flexibility.

The data-transmission capacity of the type of digital transmission system existing in the UK is more than one million bits per second (BIT = BInary digiT, i.e. a digit which can have only two values, 0 or 1. It is the smallest meaningful unit of information) and systems with much larger capacity are being developed. So that this high capacity can be used efficiently by data terminals operating at rates in the range hundreds to a few thousands of bits per second several methods have been considered. All of them are ways of sharing the use of the transmission system on a time basis, i.e. allocation of the transmission medium to each of a group of communication channels

Functional diagram of a Circuit Switching Node



Typical Circuit Switching Process (Only local call shown)

1 Local customer ABC sends address of required destination (ie XYZ)

2 Routing control examines address and labels buffer No. ABC with destination (ie XYZ) and also labels buffer No. XYZ with calling customers address (ie ABC)

3 Subsequent data characters sent by either customer are transferred according to labels

When either customer clears down labels are deleted

for a period of time. These methods are called time division multiplexing (TDM). An example of a practical six-channel system was one produced by Georges Baudot for long-distance telegraph lines nearly 100 years ago (it was Baudot who gave his name to the term "Baud").

TDM systems are often of the "frame synchronous" type, e.g. the Baudot System described above and those used for pcm telephony. A frame is a group of bits containing information from each of the channels in the multiplex. In such a system the position of a bit relative to the other bits in the frame determines the channel to which it belongs. The numbers of bits per channel in each frame may be 1, 7, 8 or more, and where the number of bits corresponds to a character, this may be called a "character-interleaved" system. Other systems may use a "label" or "address" attached to the bits belonging to each channel for identification, and in systems where groups of characters are addressed in this way they may be described as "packet interleaved". They are also a form of TDM system because subsequent packets generally represent different channels.

At first sight the proposal to combine packet and circuit switching in one exchange does not seem to offer any advantages, particularly because they appear to be quite different techniques. In fact, in the type of switch which has been proposed by the study teams, which are based on the transfer of characters or bytes (groups of bits, often 8) at regular or irregular intervals from one port (a point of entry or exit for data) to another, it is difficult to discern many differences in circuit or packet switching hardware. Some form of memory would be used for temporary storage by the switch of characters or packets in transit from input channels to output channels. Where a switching node handles synchronised TDM transmission systems, character storage would generally be necessary to delay the transfer of characters arriving in particular channels at an input port until the occurrence of the appropriate channel or "time slot" at the output port. This process is sometimes called "slot changing". One example of a system using this process is the wired program electronic PCM tandem switch, designed and made at the Post Office Research Department, which has been in operation for more than two years at Empress exchange and has successfully switched more than two million telephone calls.

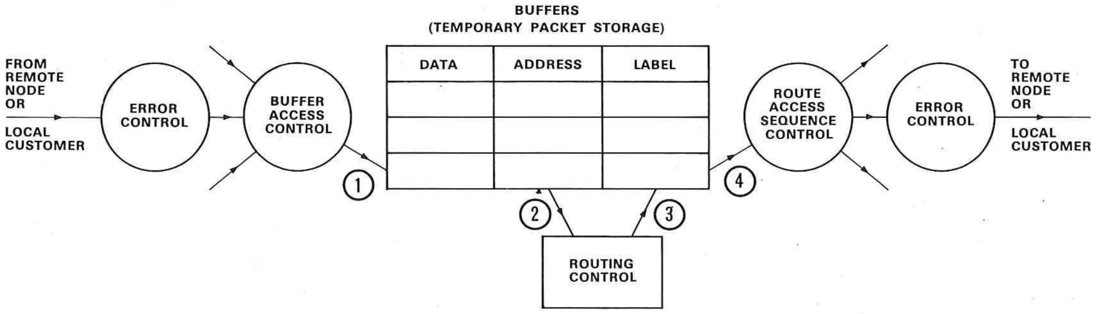
One of the main differences between the techniques of packet and circuit switching is the manner in which users communicate data. Taking the case of a user with a data processing installation which interacts with several remote installations by means of packet switching (e.g. the ARPA system); it is necessary for the user's equipment to observe rules about the format of his data, e.g. the maximum number of bits in any communication. If more than this maximum is to be communicated, the user's equipment will have to wait until a signal to send another block of data is received from the packet switching system. In addition to this, variable time delays in handling the block of data may occur, e.g. during periods of heavy use of the system. Nevertheless, packet-switching systems may offer very low probability of error. With circuit switching systems, however, once communication has been established the user's equipment can utilise the maximum rate of data transfer of the service for as long as is necessary to complete the communication, with constant time delay, but possibly with greater probability of errors occurring in data in transit.

The development of switched telecommunications has been marked by technical advances, each accepted mainly for economic reasons. The conversion of networks to automatic working, the development of high-capacity frequency division multiplex (FDM) long-distance transmission systems and the recent introduction of digital transmission have all been technical advances which have promised long-term cost benefits. In practice such advances rarely show short-term economic advantages, and several years may pass before cost benefits accrue. Nevertheless, the continuous improvement in our living standards ultimately depends on making more processes automatic, and increasing the reliability of the necessary machines.

Post Office data-communication services will become an integral part of a great number of automatic processing systems for industrial, business and other purposes. The Post Office must therefore be ready to provide improved national and international data-communication services as and when the demand appears, and the techniques should potentially offer long-term overall cost benefits when compared with the alternative methods which would otherwise be required.

Mr. M. A. Smith is a Senior Executive Engineer working on experimental and development field trials concerned with data-communication studies.

Functional diagram of a Packet Switching Node



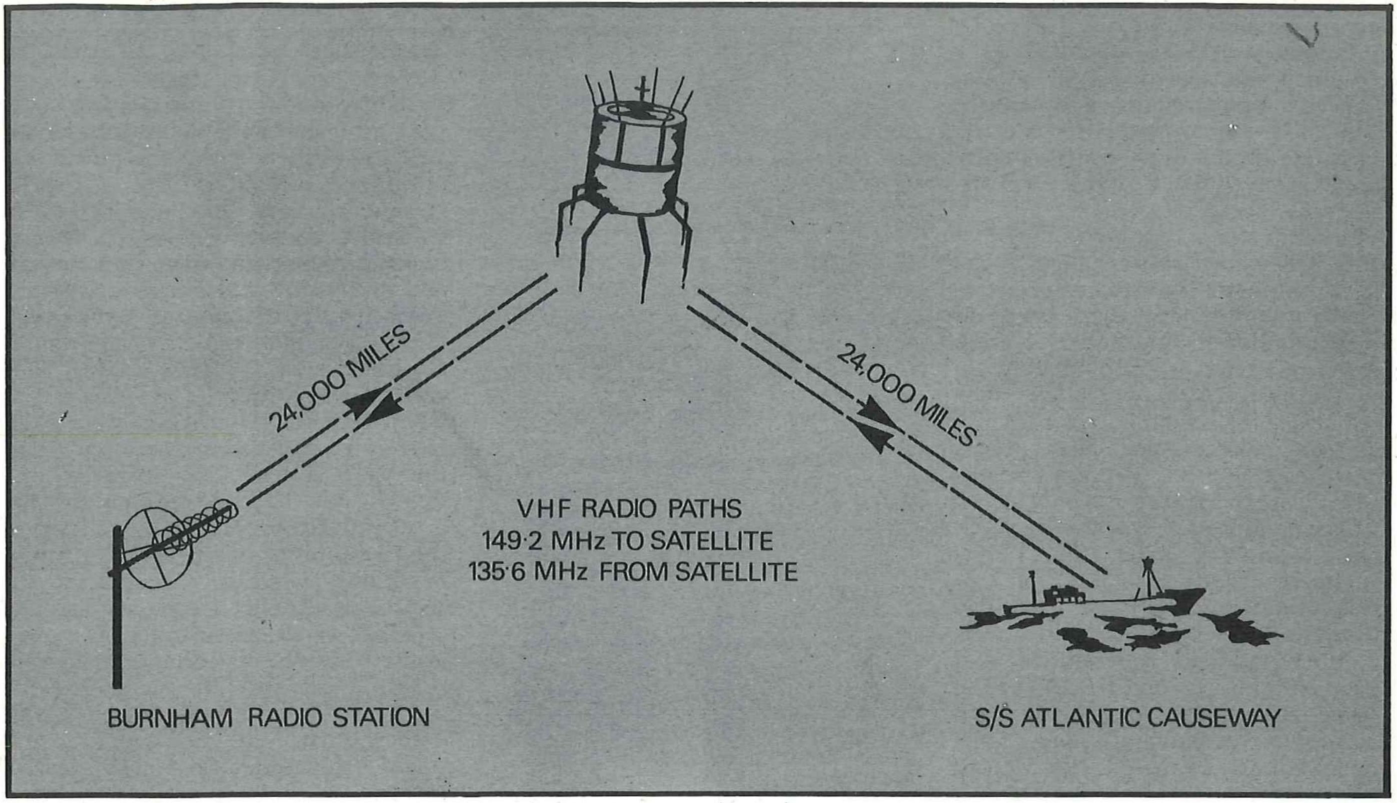
Typical Packet Handling Process (Only one packet shown in transit)

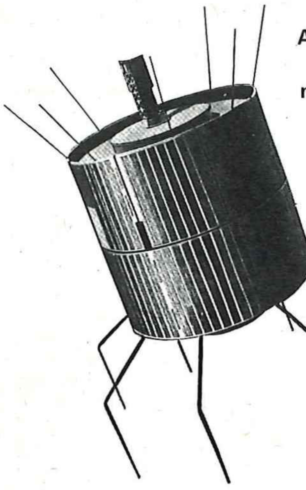
1 Incoming addressed packet enters free buffer

2 Routing control examines address and "looks up" preferred outgoing route or local customer location

3 Routing control labels packet for preferred route or local customer location

4 Addressed packet transferred to remote node or local customer





ATS-3 satellite used in the maritime tests shown above

A E Baker/ D G Pope

Ship-to-shore by satellite

SATELLITE communication with merchant ships at sea has been shown to be technically feasible in tests carried out by the Post Office, industry and shipping and radio operating organisations. It offers the prospect of a good quality, stable and reliable system and one which would enable ships almost anywhere in the world to be contacted at any time of the day or night. The radio frequencies which might be used for a satellite system are only marginally affected by ionospheric conditions which can have a very detrimental effect on the high frequency radio circuits.

At present, the ship-to-shore service uses the VHF and MF bands for distances of about 50 and 300 miles respectively and the HF bandwidth for long-distance communication. The latter is particularly affected by poor conditions which can cause fading and even, at times, complete loss of signal. Indeed, the frequency to be used has to be selected according to the conditions applying at the time and contact with ships in some parts of the world is as a result only possible at certain times of the day or night.

While satellite communications using fixed earth stations are now used throughout the world, a maritime system where one of the stations is extensively mobile over the surface of the earth is relatively new. Tests of this form of communication, however, were carried out in 1968 by the US Coastguard Service and more recently by the Administrations of the Federal German Republic and the Netherlands.

The UK tests in the latter part of 1970 were carried out between two terminal stations—one at the Post Office Radio Station at Burnham near Bristol and the other on board the Cunard-Brocklebank container ship SS Atlantic Causeway whose normal route was from Greenock in Scotland to Goteberg (Sweden), Halifax (Nova Scotia), New York, Portsmouth and Baltimore (USA) and back again to Greenock, a round trip of about three weeks. The test period covered six transatlantic voyages by the ship.

The range of tests covered telephony, with and without speech processing using Companders or Lincompex; facsimile transmission using test charts and meteorological charts; teleprinter transmission and selective calling using both the ship's unique calling code and the "all ships" code (see "Better Radio for Shipping", Telecommunications Journal, Summer 1970).

One of the problems of a maritime satellite system is to keep the ship's aerials pointed towards the satellite. The aerial development for use on the ship was a multi-element crossed Yagi aerial, not unlike those used for television reception, and it had a sufficiently broad beam to enable the satellite to be "seen" without the need for stabilisation. The aerial enabled some assessment to be made of the difficulty of aligning it with the satellite and of the effect on reception of the rolling and pitching of the ship. The Yagi aerials also made it possible to use equipment closely akin to that already employed in mobile communications units.

At Burnham Radio Station a 300 watt transmitter was installed which operated into a crossed Yagi aerial. On the receive side, either a crossed

Yagi or a helical aerial was used. The equipment could be operated as a frequency modulated (FM) system, the IF bandwidth being switchable to either 10 kHz or 20 kHz. Alternatively, amplitude modulation in the double-sideband-suppressed-carrier (DSB-SC) mode could be used.

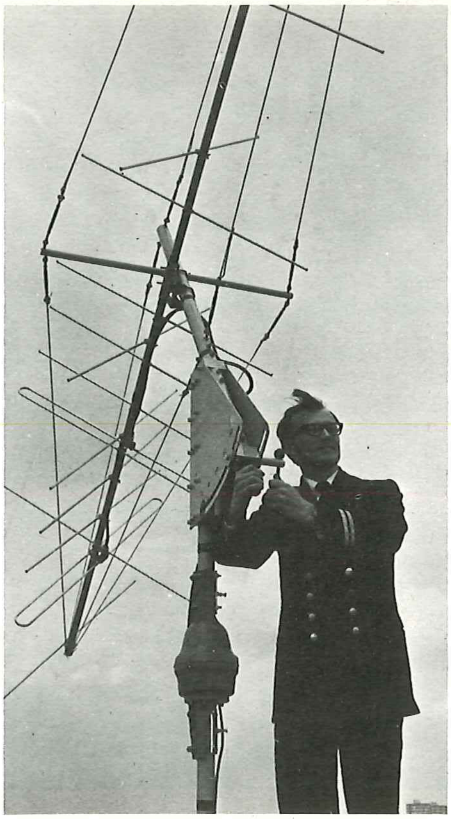
The ship's radio equipment, part of which was loaned and installed by the US Coastguard Service, was operationally similar to that used at Burnham, but in addition to a high gain Yagi aerial (approximately 40 degrees beamwidth) which could be used either for transmitting or receiving, low gain crossed Yagi aerials (approximately 80 degrees beamwidth) were available.

The satellite used was the Application Technology Satellite (ATS 3) which was made available for two threequarter-hour periods each day throughout the duration of the tests by the National Aeronautics and Space Administration (NASA) of the United States. It can provide both microwave (broadband) and VHF transmissions facilities, the latter being used for the maritime tests.

VHF aerials spin with the satellite body but are electronically despun and phased to provide directivity towards the earth. The VHF transponder has a bandwidth of about 100 kHz, and low-level signals received at the satellite at a frequency of about 149.2 MHz are frequency shifted, amplified and retransmitted towards the earth at a frequency of about 135.6 MHz with an effective radiated power of some 100 watts. These frequencies in fact, lie within the VHF aeronautical band and on occasions during the UK maritime tests aircraft transmissions were intercepted.

During the first two voyages of the Atlantic Causeway the equipment was optimized and after this a regular routine of tests was conducted. In spite of occasional equipment failure, including icing-up of the ship's aerials and buffetting by Force 12 winds, good quality telephone service was often obtained and the teleprinter, facsimile and selective calling tests showed a high degree of success even when reception conditions were poor. However, difficulties due to fading of the VHF signal were observed, and this is one of the reasons for the growing interest now being shown in the possibilities of operating a future maritime satellite communications service in a higher frequency band.

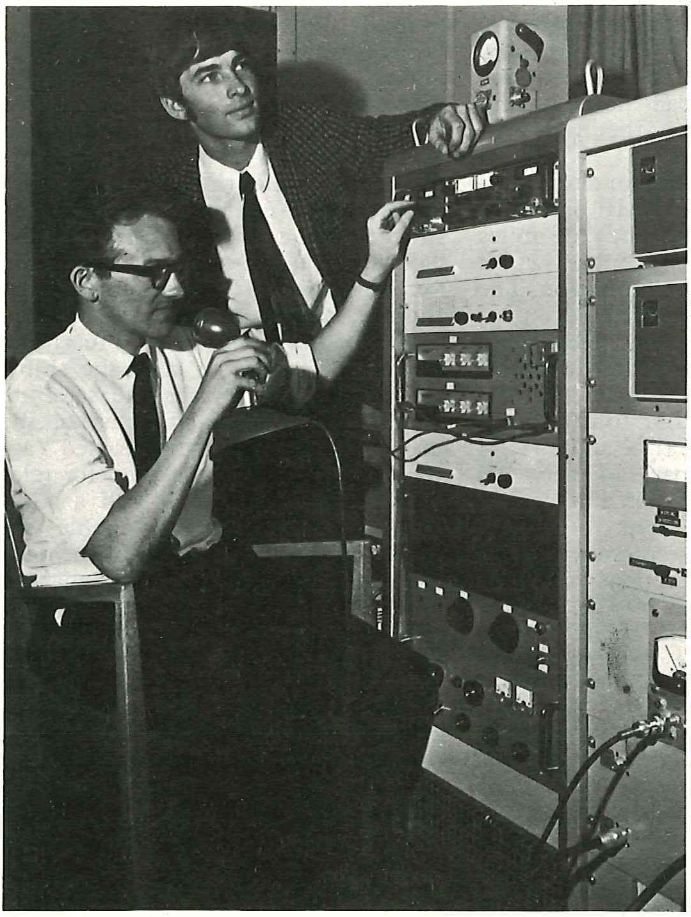
Three satellites suitably positioned around the geo-stationary orbit could be capable of providing a world-wide commercial service for ships at sea. The results of the UK tests are still being evaluated and a great deal of interest in such a service is being shown by British shipping and maritime radio manufacturing companies.



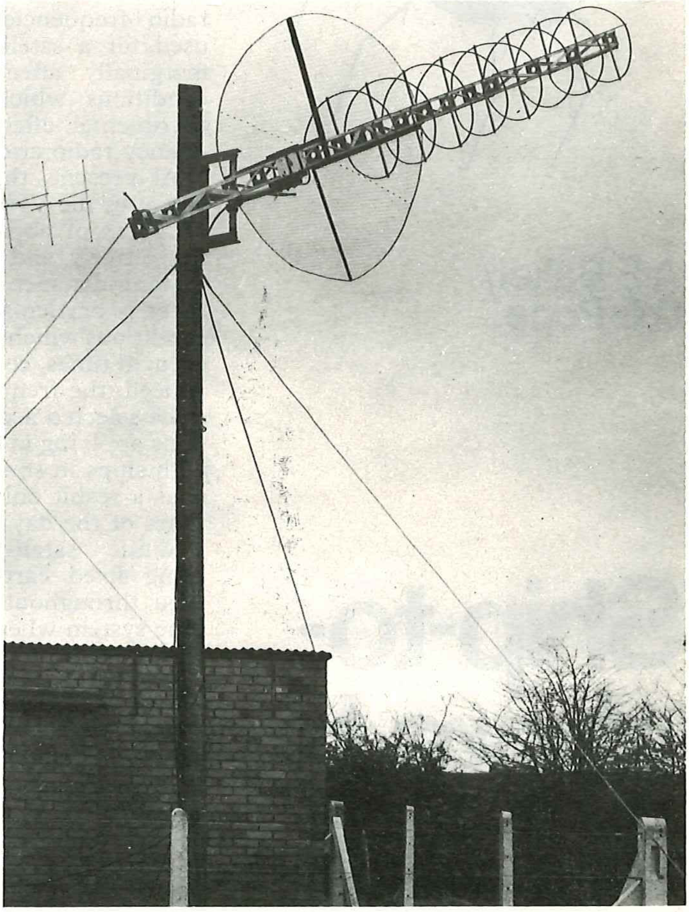
A crossed-Yago aerial array was used on the Atlantic Causeway. Its broad beamwidth eliminated the need for stabilisation against the ship's movement.

Mr. A. E. Baker is an Assistant Staff Engineer in Space Communications Systems Branch of Telecommunications Development Department responsible for the long-term planning of satellite systems.

Mr. D. G. Pope is a Senior Executive Engineer in the same section working on regional, mobile and miscellaneous applications of satellite systems.

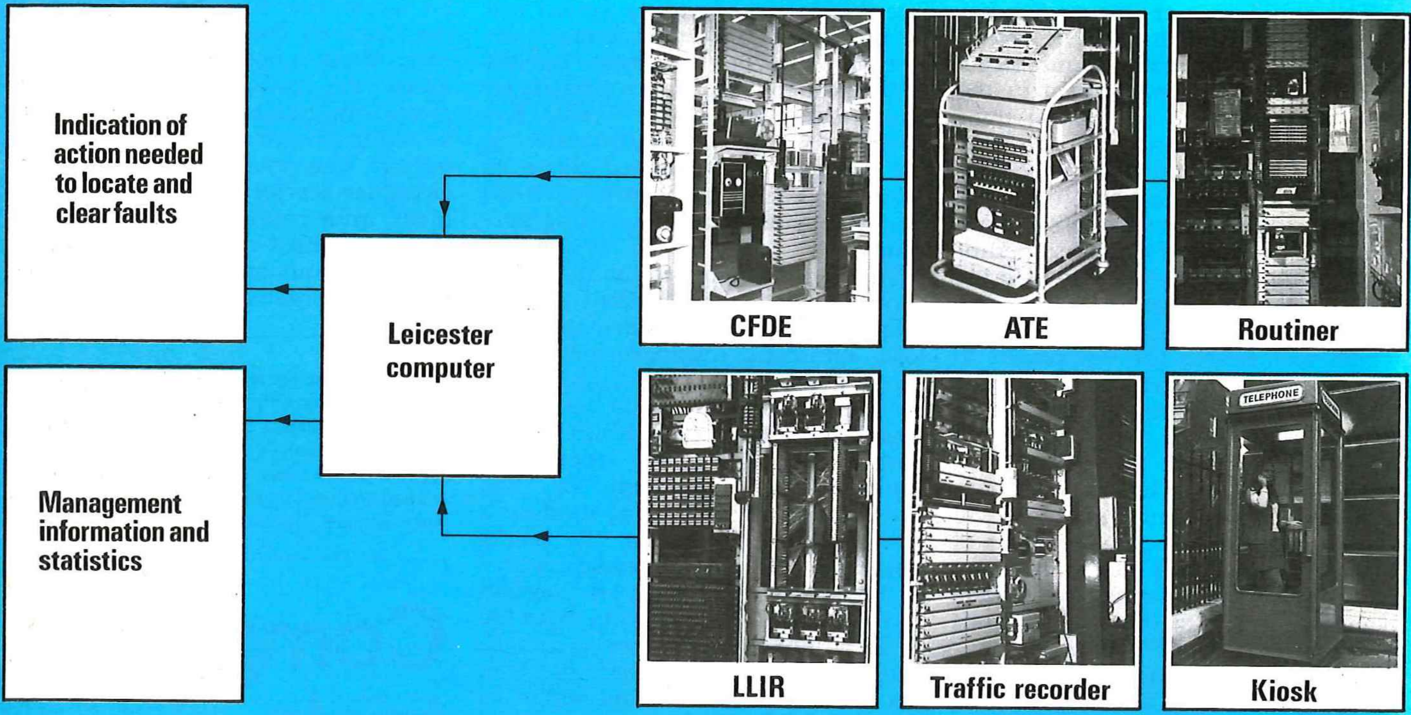


Below, left: equipment specially installed in the ship for the satellite tests.



Below, right: an aerial at Burnham radio station used in the tests.

A NEW MAINTENANCE AID–THE COMPUTER


Indication of action needed to locate and clear faults
Management information and statistics
Leicester computer
CFDE
ATE
Routiner
LLIR
Traffic recorder
Kiosk
TELEPHONE

D C Butterworth

MANY types of equipment have been used over the years to help achieve higher standards of maintenance in the telephone network. None, however, has had the impact that is likely to come from the latest innovation—a computer system to keep a round-the-clock watch for faults in exchanges and on customers' lines and which could well pave the way for considerable changes in maintenance methods over the next decade.

After a little more than three years of backroom planning and designing the Post Office is to launch a prototype trial of such a system early next year, known as CAMP (Computer Aided Maintenance Project). The majority of the system equipment will be tried out at Leicester—an area with a fair spread of the larger electromechanical exchanges which are likely to benefit most from computer-aided maintenance.

A small Ferranti Argus 500 computer housed in the Area's West Wigston exchange building will gather information from 22 exchanges serving 79,000 numbers. It will monitor performance and draw instant attention to faults and impending breakdowns by sending a teleprinter message to maintenance engineers in the exchange concerned, enabling them to start repair work much earlier than was previously possible. Monitoring will be done over a data network, consisting in the main of 50 baud telegraph lines, which will connect the 22 exchanges to the computer centre. The computer message will be reproduced at the exchanges on Teleprinters No. 15.

The computer will also help network development staff to assess where additional plant is needed by tracing the pattern of calls and identifying the most commonly used routes and by keeping a constant check on the volume of calls being made. It will analyse signals from the equipment-testing devices already used to provide engineers with information about faulty equipment. The analysis will show where overhaul is needed and provide an additional safeguard against breakdowns.

As far as possible it is intended that input data for the computer will be collected on-line (direct) from the equipment-testing devices and, while no new basic equipment is being developed for the trial, a great deal of effort will be necessary to convert existing equipment, routiners etc., to permit this on-line collection and where necessary the control of the equipment by the computer.

The CAMP trial will provide help in three broad areas of maintenance work—the exchange network, exchange equipment and customer service. From within these three areas the particular tasks selected for CAMP are Network Surveillance, Traffic Analysis and Recording, Routiner Output Analysis, Equipment Fault Incidence Record, TXK (crossbar) and TXE (electronic) Fault Report Analysis, Local Line Insulation Routiner Analysis, Repair Service Control and Public Call Office Monitoring.

Network Surveillance is to be carried out by monitoring live traffic and keeping computer records of all such calls that fail to produce one of the standard tones, for example Ring and Busy Tones. Together with customer reports of difficulty in obtaining particular numbers, which will be input to the computer from Fault Reference Centre, these records can be analysed to determine if any coincidences exist which could indicate trouble in a particular switching stage of the exchange network. If each failure is analysed immediately it is possible to direct engineering effort toward a particular location and also to arrange that, if necessary, the equipment utilised when this failure occurred is held for the fault to be traced. In this way it should be possible to remove from service individual items of equipment that might otherwise remain undetected for some time and so improve the service from the customers' viewpoint.

The equipment chosen to monitor the live traffic is the CFDE No. 3 (Call Failure Detection Equipment) which permits the equipment in the faulty connexion to be held for trace while allowing the subscriber to clear down in order to try to establish his call a second time. So that the computer can be aware of the information monitored by a CFDE and to permit it to decide whether or not to hold the failed call for trace, an electronic interface unit has been designed which will enable the equipment to work to the computer over one of the 50 baud data links mentioned earlier. Some 15 of these modified CFDEs will be employed in the trial.

Artificial Traffic Equipments with a similar type of interface unit will also be used to probe suspect parts of the network where CFDE results are not conclusive; their failure reports being subjected to the same analysis as those from the CFDEs.

A large percentage of the calls monitored by the CFDEs should be successful calls and it is possible to analyse these by destination so as to provide the proportions of traffic over the routes between the various exchanges in the network and the breakdown of tandem traffic. This analysis, carried out at regular intervals, could for example indicate when an existing route via a tandem exchange could profitably be made direct and, if this were done, what spare capacity would then exist at the tandem exchange. This type of traffic analysis can be regarded as a useful "spin-off" from the network surveillance task since no additional equipment is needed and to collect this information in other ways would be both costly and time consuming.

The remaining task within the switching network concerns traffic recording. Developments to permit computerised traffic recording were already in progress in Telecommunications headquarters and as the needs of the data network, computer facilities and timescale were similar to those of CAMP it was decided to incorporate it in the Leicester experiment. This will involve the on-line collection of the data from Automatic Traffic Recorders in selected Strowger exchanges and the control of these recorders by the computer. A special scanning and control unit will be installed to permit this new type of working.

The collected data will be processed to determine the volume of traffic carried by individual circuit groups to produce locally a traffic summary and traffic balance for each exchange. Selected parts of the data will be forwarded over a computer-to-computer link to the Long Lines computer in London to prove the technical feasibility and usefulness of this type of transfer.

All items of equipment detected permanently busy or permanently free during the recording period will be printed out on the exchange teleprinter for corrective action. Subject to the availability of spare capacity on a particular Automatic Traffic Recorder it is hoped that information on the calling rates of selected classes of customer lines may be produced for design, planning and forecasting purposes.

In order to remove individual items of faulty or potentially faulty equipment from service before calls are lost, automatic routiners have been used for some time to test equipment at regular intervals and note for attention all those items which are not within the prescribed operational limits. These routiners are run throughout the night and produce a series of "dockets" for the faults observed during the routining cycle.

The task of designing an interface to enable these fault reports to be fed directly into the computer is complicated by the fact that there are over 100 different types of routiner to be interfaced, but a design is now progressing satisfactorily. By connecting them directly, the computer will be able to sort all the fault symptoms into equipment types and produce job lists for specific duties before staff arrive for duty each morning. These fault symptom reports and the trouble found will be fed to another computer along with other types of fault reports and clearance data, so that equipment fault incidence records can be computer produced. This relieves engineering staff of a good deal of the clerical work and the statistical information that could be derived from such an extensive fault history will be of great value to management.

The Leicester experiment will include attempts to monitor a few selected Public Call Offices at busy locations such as railway stations which when out-of-order are a source of frustration to customers, and perhaps potential customers. The aim will be to detect deviations from normal usage. On the assumption that such deviations are most likely to arise from faulty kiosk equipment, it should be possible to alert appropriate maintenance effort very quickly.

Because of the very wide range of maintenance activities to be tackled a very versatile computer is needed. The Argus 500 meets this requirement and also has a high reliability and needs the minimum of special accommodation. The cost of the computer configuration is in the order of £180,000 and because the techniques employed are both flexible and modular it will permit other aids to maintenance to be developed and evaluated as the main CAMP trial proceeds.

At present the Post Office spends £39 million a year on maintenance of telecommunications plant—a large part of it on servicing exchange equipment. This work and the maintenance of customers' lines accounts for 45 million man-hours a year. If the Leicester trial is successful, however, about 2,000 exchanges up and down the country—all the larger electro-mechanical exchanges—could be similarly served by about 60 computers. The result would be a better customer service, improved management information and the relief of highly qualified engineering staff from the more mundane duties involved in present maintenance procedures.

Mr. D. C. Butterworth, a Senior Executive Engineer in Post Office Data Processing, joined the CAMP project in 1969 and has been particularly involved with the LLIR and RSC aspects of the trials. Prior to joining PODP he worked in the computer division of Management Services Department.

Computer trials elsewhere

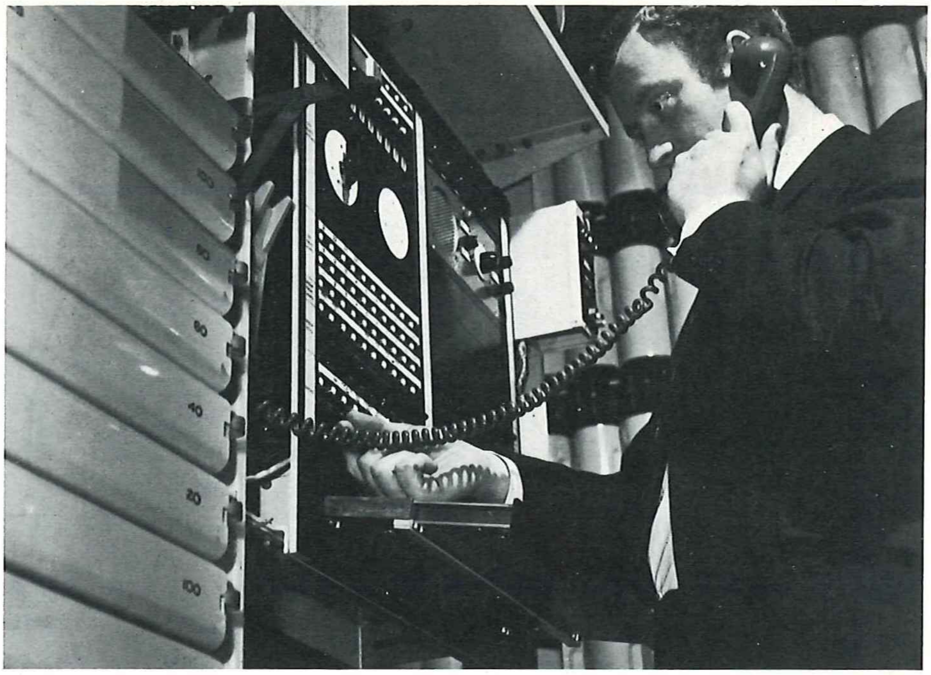
While the greater part of the Computer Aided Maintenance Project is to be conducted at Leicester there are to be trials of other equipment elsewhere. These additional trials remain a vital part of the overall scheme.

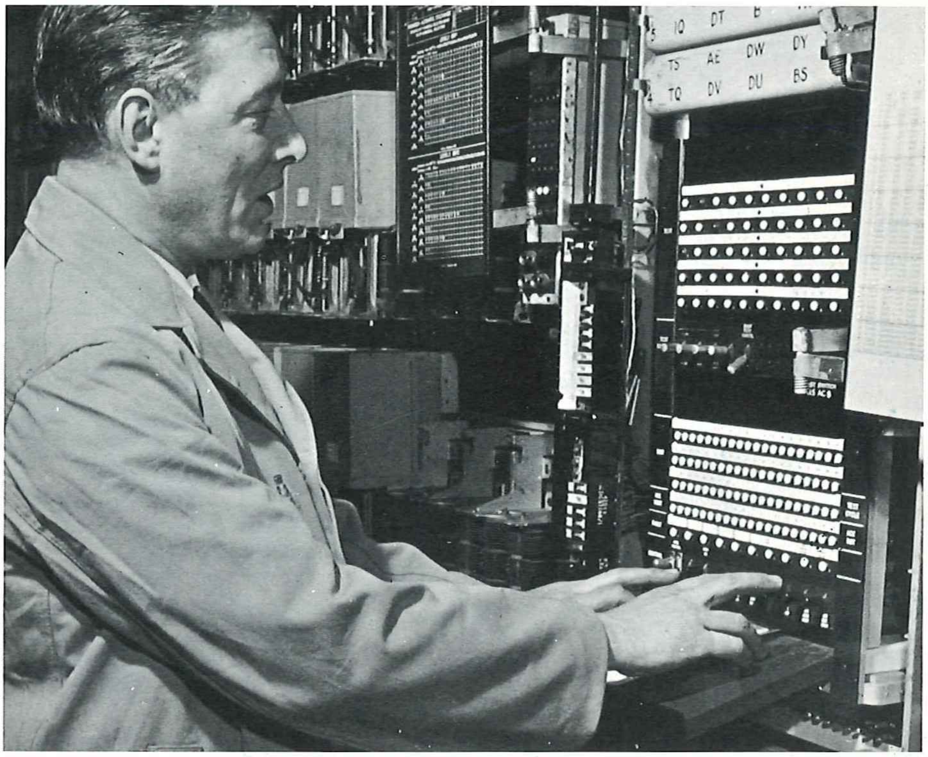
They involve the application of a computer technique to the maintenance of crossbar and electronic exchanges and the testing of a prototype system which allows Local Line Insulation Routiners to output computer readable papertape.

Unlike Strowger exchanges, crossbar and electronic exchanges have several items of test gear built-in which produce on a teleprinter or other device fault reports of many kinds. The outputs are coded and each type has a distinct format; analysis involves correlation of similar outputs which is difficult to do manually, and can be more readily and quickly carried out with the aid of a computer. Initially a computer technique is to be applied to the outputs of new exchanges at Ingatestone and Upminster in Essex and will be extended to eight exchanges in the Coventry Telephone Area to prove existing ideas and to assist with the design of future systems. A Post Office Data Processing computer in London will be used. When similar exchanges are installed in the Leicester Area they may also use the same

Right: an engineer checks Call Failure Detection Equipment of the type which will monitor live traffic for the CAMP project. This CFDE allows equipment which has caused a faulty connexion to be held for trace even though the subscriber has cleared down. The computer will monitor a number of CFDEs and can decide whether it is necessary to hold the failed call for a trace.

Centre and below: an automatic routiner which runs throughout the night and tests equipment for faults. Its reports are produced in a series of dockets which are being checked by a maintenance engineer (below) on arrival for work in the morning. An interface is now being designed which will allow fault reports from a number of different routiners to be fed direct into the computer which will then sort the faults into different types and produce job lists for specific duties.





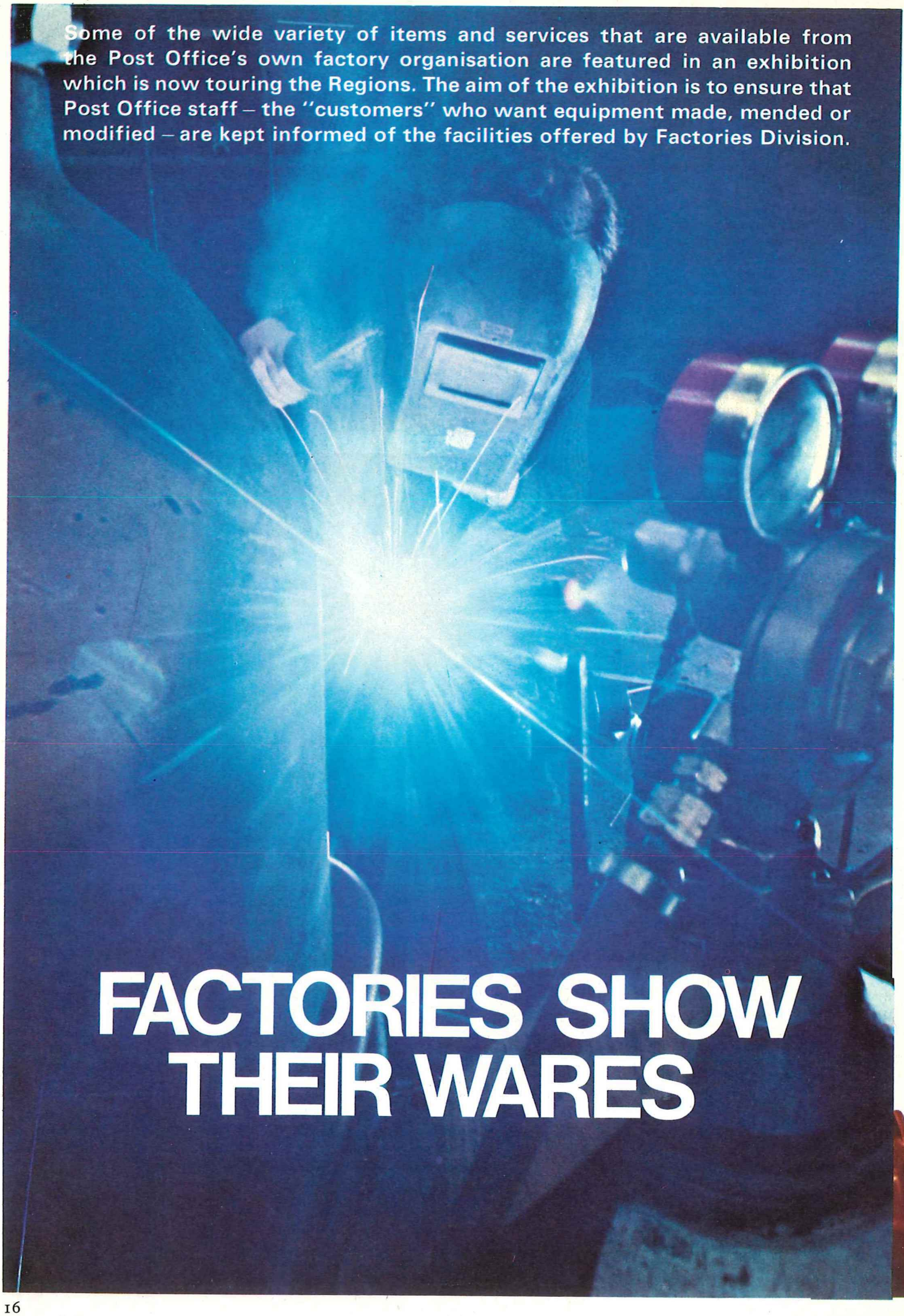
PODP computer centre in London.

Tests of the prototype system for Local Line Insulation Routiners have been going on for some months now at the Shirley exchange in Birmingham and at five other exchanges in Manchester North using another London Computer.

At present the Routiners provide as output a list of subscribers' numbers whose lines fail some preset standards. Correctly interpreted, the output can often indicate faults well in advance of an actual breakdown. Unfortunately, the output is produced first in papertape form, has then to be converted to subscribers' numbers and ultimately to cable plant form before it can be of any use. Done manually it is a lengthy task, but a computer could process the data very quickly and produce required analyses at the operational site concerned—usually the External Plant Maintenance Control or the Repair Service Control. An interface is being designed to allow the Routiner to output computer readable papertape.

The prototype trial appears to be very successful and is currently being evaluated. If it is shown to be as economical as it is useful, plans for wider extension will be made. Certainly, it is expected that some assistance in this area will be given at Leicester as the trial there progresses.

So far as the Repair Service Control is concerned, it has been decided that a comprehensive work study survey lasting several months should be carried out before an attempt is made to provide computer assistance in this complex and difficult area. The study, however, should produce a mass of information on future approaches, both computer and manual, and this will be taken into account when the form of computer assistance in this work area is re-examined.



Some of the wide variety of items and services that are available from the Post Office's own factory organisation are featured in an exhibition which is now touring the Regions. The aim of the exhibition is to ensure that Post Office staff – the "customers" who want equipment made, mended or modified – are kept informed of the facilities offered by Factories Division.

FACTORIES SHOW THEIR WARES

PMBX flowline at Enfield

IN 1870, when the Post Office took over the assets of various telegraph companies, two small factories in London and Bolton were among the acquisitions. They manufactured and repaired telegraph equipment and batteries, and employed 175 people.

From this small beginning came the Post Office Factories, and since then they have been engaged in 100 years of progress and expansion to match that of the telecommunications service. Today there are eight Factories—three in London, three in Birmingham, one in Edinburgh and one in Cwmcarn, South Wales. The staff of about 3,400 men and women assemble, repair or manufacture anything from the public viewing telescopes for London's Post Office Tower to mobile telephone exchanges.

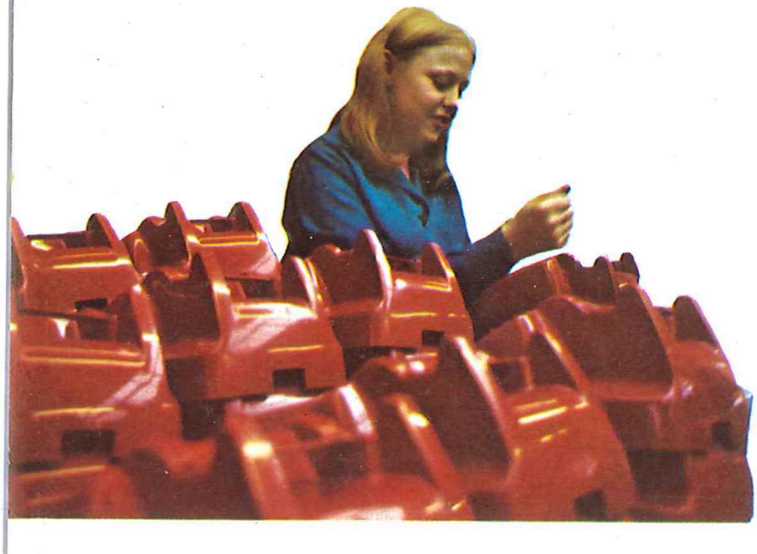
The Factories get their work from many quarters. Supplies Division rely on them for a programmed flow of repaired equipment to replenish their stocks. Contracts Division call on them to manufacture equipment for particular needs which cannot be met from other sources, and invite them to tender to manufacture various kinds of equipment for general supply. Headquarters Departments seek their help in a variety of ways —to undertake conversion programmes concerned with the introduction of STD and decimalisation; to provide centralised servicing facilities for new kinds of equipment as they are introduced; to develop and produce the prototypes for new designs and generally to make available their production engineering knowledge and capability. The Regions and Areas go to the Factories for help in many ways—to renovate and modify exchange equipment on a scale which is beyond the resources of the local staff or which could be carried out more economically in the Factories; to construct a variety of non-standard equipment for special purposes; to supply them with millions of labels every year and with a vast number of automatic exchange piece parts.

Factory resources reflect the wide range of their activities. They include a large machine shop and modern tool room; cabinet making and woodworking shops; plant for spray painting, automatic stove enamelling, plating, electro polishing and other finishing processes; fitting and metalwork shops, coil-winding machines, hot-press printing machines, shot blasting and ultrasonic washing plant.

Production costs are of vital concern to the Factories, for if they did not remain competitive with outside prices they would go out of business. They have been first in the field in developing and applying a number of new production techniques, including automatic screw sorting, the electro-polishing of stainless steel and automated pallet transportation.

Nearly all production work is carried out under piecework conditions, thus encouraging high productivity. The piecework earnings are based on the time saved by the operative or team carrying out the work, as compared with the "allowed" time, which for repetitive jobs is derived from time studies. Methods and processes are developed by work study and, whenever the output is large enough, work is carried out by flowline or sectionalised methods.

Left: Welding at Enfield
Below: Telephone repair at Cwmcarn



14 million labels

The work of the Factories ranges from the printing of 14 million labels a year to the "one-off" construction job. At one end of the scale are the big repetitive jobs like the mass repair of equipment which has been recovered from the field—producing annual figures of 664,000 telephones, 510,000 dials, 251,000 bell sets, 81,000 plan sets, 47,000 power units and 21,000 PMBXs. Other major projects include bulk production of relays (750,000 a year), relay sets and piece parts, using recovered parts wherever possible, and national modification programmes for updating working exchange equipment. At the other end of the scale are a host of small renovation, conversion and repair jobs. Items constructed include mobile exchanges, automatic call senders, special-purpose furniture and fittings and instrument cords.

CONTROLLING THE SKYWAYS

G W Young/
J L Harriss

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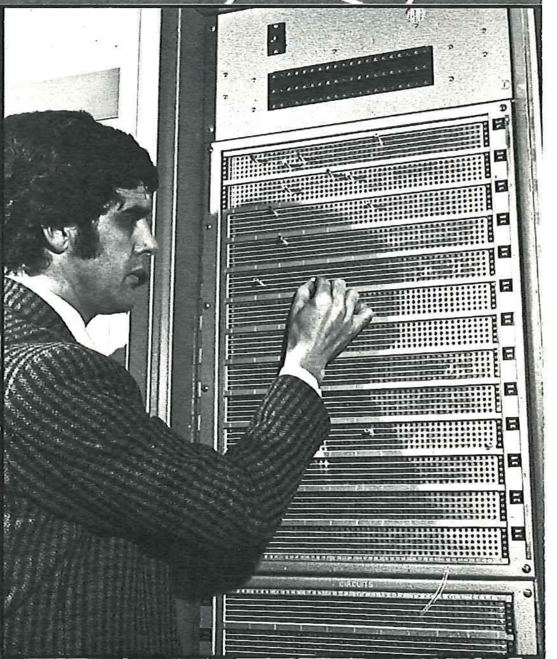
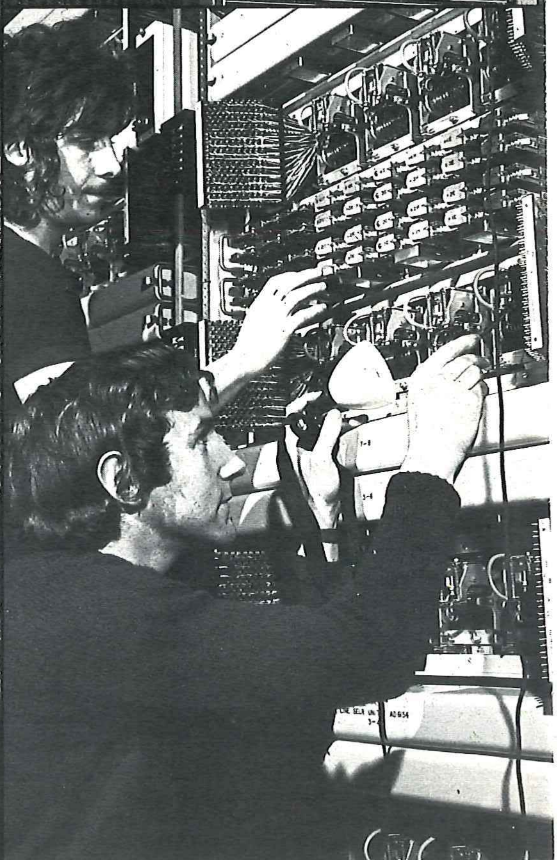




THE control of aircraft flying over the United Kingdom has become a very complex business in recent years. The increasing number of passenger-carrying, freight and military aircraft, the heavier loading of the upper air space by high-flying jets and the introduction of supersonic aircraft have combined to tax severely the manual control systems at present being used.

To cope with the problem a modernised air traffic control system —known as "Mediator"—is being introduced in stages by the National Air Traffic Control Service of the Department of Trade and Industry. The Post Office is playing an important role in the development and provision of specially designed telecommunications equipment.

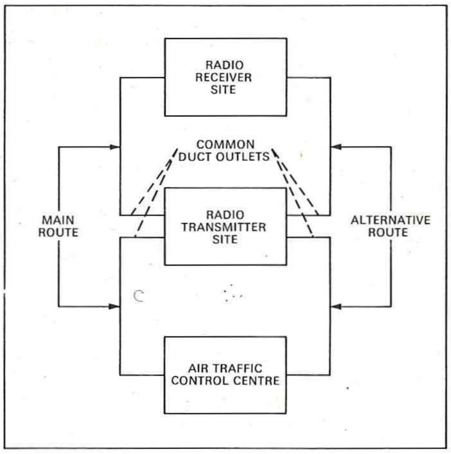
The present manual system requires a number of control centres throughout the UK, each responsible for a particular area of air space and connected over teleprinter, telegraph, telephone and sometimes closed-circuit TV links. By contrast, "Mediator" as at present envisaged will enable just three control centres at West Drayton (London), Manchester and Prestwick to control all aircraft flying over the UK. Air Traffic Controllers will sit at consoles which provide all the facilities required for accurate and speedy decision taking. They will have access to radio and radar, and eventually control of computer input and output enabling fast calculations to be made and immediate information to be obtained on flight plans stored in the computer. Telephone services include direct point-to-point circuits and a network of private circuits between PABXs with long-distance dialling equipment to provide contact with approximately 120 out-stations, airports and other Air Traffic Control units of various sorts including units abroad and National Air Traffic Control Service radio and radar scanning stations throughout the country. The consoles have access to this telephone network by means of a repertory dialling telephone keyboard system specially designed by the Post Office to suit the unique requirements of air traffic control.

Opposite left: an Air Traffic Controller spots an aircraft on a radar display screen. The small TV screens directly in front of him provides other urgent information at the touch of a button. The keypads on the extreme left of the picture give access to the facilities provided by the Post Office.

Opposite top: a Technical Officer inserts a plug into a matrix, part of the automatic flexibility switching unit developed by the Post Office for "Mediator". The matrix indicates operating position keys and lines and enables up to 130 keys to be switched to any one of 50 direct point-to-point circuits. Once a plug position has been changed the remainder of the operation is carried out automatically by the line switching unit (bottom picture).

The first part of "Mediator" went into service at West Drayton in February. The remainder of this article describes the work done by the Post Office for this first part.

Numerous lines have been provided for data transmission, digitised radar, radio telephone transmitters and receivers and remote display of radar presentations. The Post Office was asked to provide high-grade speech circuits between West Drayton and radio transmitting and receiving stations over two physically separate routes to ensure as far as possible that communication is maintained with aircraft at all times. This work involved a great deal of special plant provision, often in mountainous areas but by careful planning in Network Planning Department it was possible to combine some of these demands with ordinary junction requirements so economising in capital outlay. On average 24 circuits are split over two routes. Approximately 30 stations are involved and the National Air Traffic Control Service can supplement these arrangements by remotely switching the lines to alternative equipment. In some circumstances Post Office cables have had to be terminated in a non-standard manner using commercially produced fibre glass cabinets containing terminating blocks, test links and in some cases line transformers.



The alternative cable routes.

When planning the various telephone services for the system, the degree of urgency with which calls would be required was first determined. For calls which demand the greatest degree of urgency, relay access point-to-point circuits give immediate direct connexion by the operation of a key so eliminating any need to wait for a call to be dialled out and avoiding any risk of circuits being engaged.

The national automatic private-circuit network which has been developed is used for calls with a lesser degree of urgency. Repertory dialling and keysending between all centres within the system is provided. It is based on the use of PABXs, mainly situated at airports throughout the country, as through-switching centres with AC 13 and DC signalling systems which allow dialling over long distances. This type of switched dialling network economises in private circuits by enabling those used for the less urgent operational requirements to be shared.

Repertory dialling was considered necessary because Traffic Controllers were used to operating a single key to obtain access to circuits and it would have been unreasonable to complicate their procedures by introducing dialling or manual keysending. However, manual keysending is provided to cater for calls to less frequently required destinations.

The keyboard system was designed by Air Defence Group of the then Subscribers' Apparatus Branch, now a part of Marketing Department, around an electronic keysender developed at the time by Ericsson's Telephones who were also commissioned to instal the keyboard switching equipment as a whole.

The electronic keysender includes a uniselector/capacitor store where digits keyed-in are stored and converted into Strowger pulses. The necessity to listen for dial tone is eliminated by the use of a transistorised detector circuit which tests the PABX extension by measuring circuit conditions and allows the keysender to inject the Strowger pulses into the PABX under the control of a binary counter. The keysender hunter enables the keysenders to be treated as short holding time equipment and so be used economically.

The repertory unit consists basically of a uniselector hunting for an outlet marked when a press button is operated on an air traffic control console. The position of wipers on associated arcs indicates to the keysender store the digits required. Up to 20 digit trains are available which could allow international dialling. By using specially developed edge-mounted rotary switches each marked with the digits 1 to 0 it is possible to alter the repertory codes at will. This is done simply by setting the switches to the desired digits. Rewiring is eliminated.

Direct access between consoles via local PABX numbers over final selector multiples is made possible by uniselectors which enable the normal PABX pulsing and switching time to be avoided. The incoming answering circuit enables calls to be received via the final selector multiple. In both cases the PABX "P" wires are extended for signalling and to permit PBX type hunting. The position circuit provides the Traffic Controllers with the usual transmitter feeds and is used on radio and or telephone circuits as required.

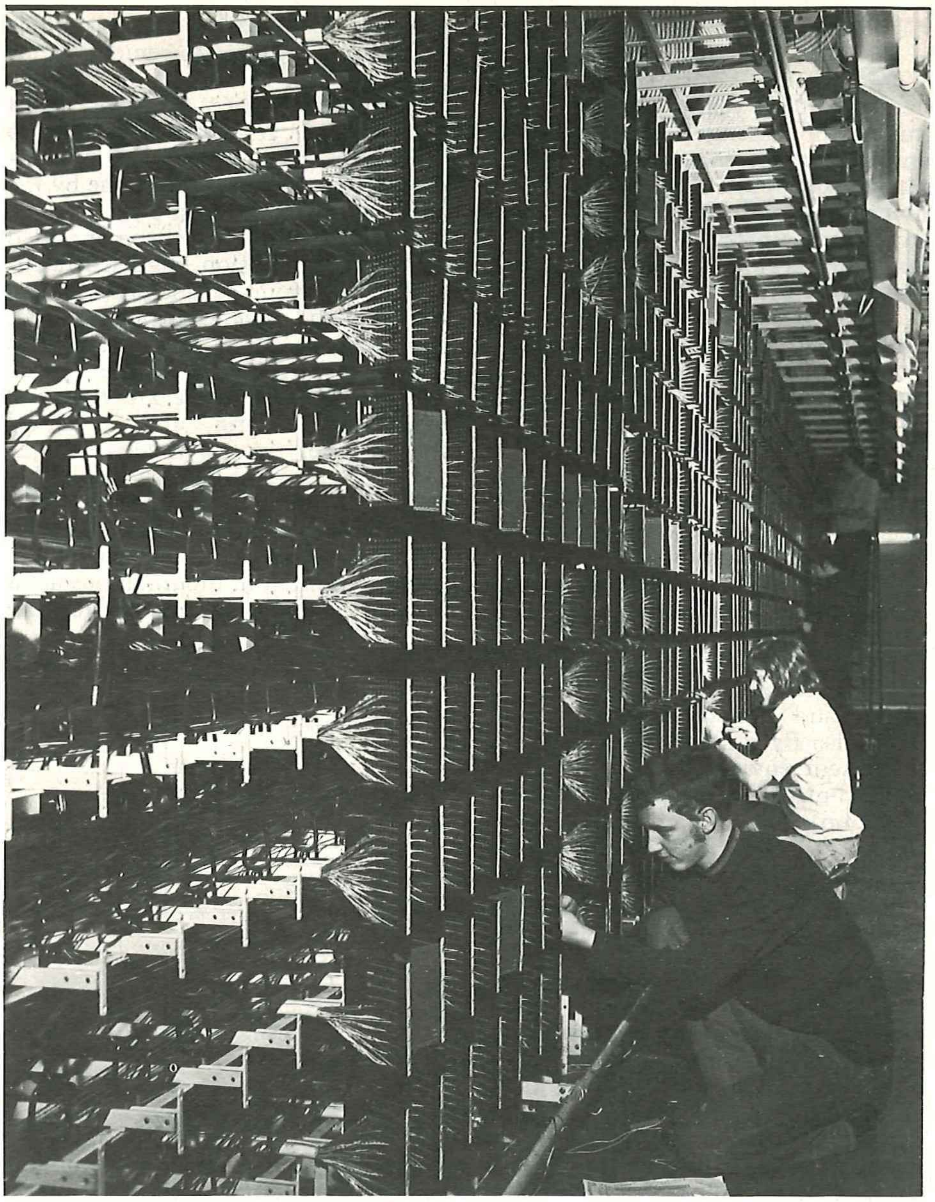
Very little inter-rack cabling is used, each item of equipment, with the exception of the keysenders, is brought out to the intermediate distribution frame to ensure full flexibility of inter-connexion of the many diverse facilities available. Further flexibility is provided by change-over panels or patching jack field enabling external lines to be patched to consoles as required. A special automatic flexibility switching unit has also been developed, which is remotely controlled from the console area by inserting miniature plugs into a matrix representing console keys and lines. The plugs contain small lamps which enable the operations staff to see at a glance the patching pattern in use at the time.

The equipment provided by the Post Office could eventually serve approximately 200 consoles at West Drayton each equipped with keyboard panels including keysets which provide on average 40 to 50 press buttons per console. Large quantities of distribution cables are required to cater for an installation of this size. Main distribution cables are taken through the cable void and terminated on keyboard distribution frames each of which serves a console area. Smaller cables terminate on frames serving individual consoles. These frames are used jointly by the various contractors responsible for sub-systems.

Flexible cables from the smaller frame connect with the console via plugs and sockets in its base. Most of the consoles cater for many facilities apart from those of the telephone keyboard system and so are cabled internally by the National Air Traffic Control Service. Responsibility is handed back to the Post Office at sockets installed underneath the operating surface of the consoles, into which keyboard panels designed on a modular basis are plugged. This modular form of keyboard panel remotely operating switching equipment is essential to ensure ease of maintenance. The panel can be replaced quickly without any disruption of service to the console and the suspect panels tested elsewhere. The remote switching equipment can also be faulted, routined or modified with minimum interruption to service.

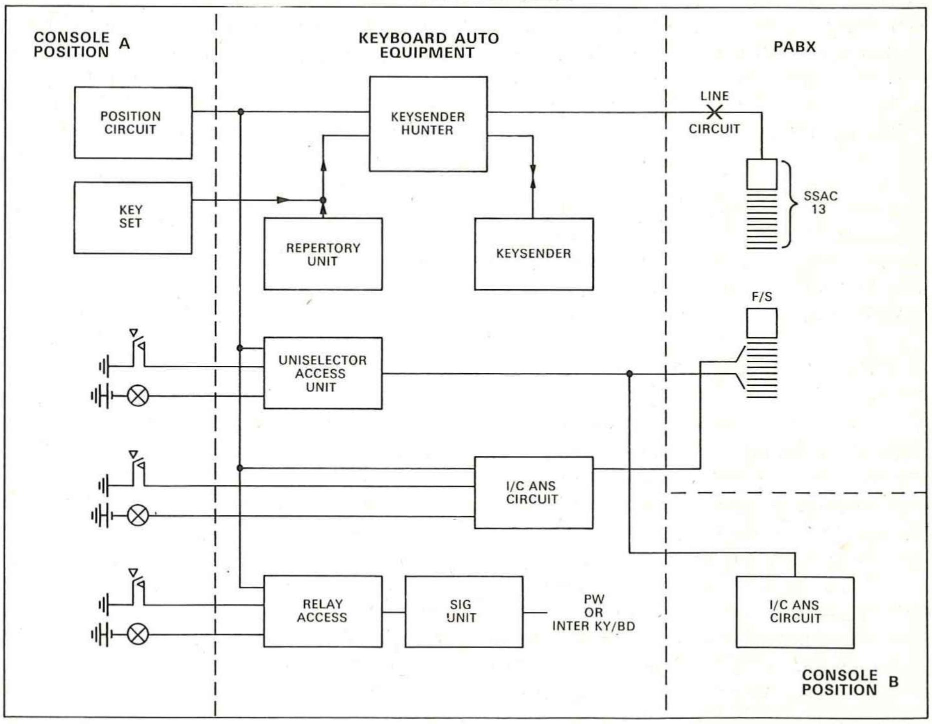
It is inevitable in a system of such complexity, containing many coordinated sub-systems, that continuous changes in requirements should be necessary. It is a tribute to Telecommunications Headquarters planning and design engineers of the early and mid-60s; and staff of the London Telecommunications Region, West Area, that the Post Office has been able to complete this large task by the finally agreed date.

Mr. J. L. Harriss is the Senior Executive Engineer and **Mr. G. W. Young** an Executive Engineer in the THQ/MkD group which designs and plans the installation of special communications systems for the RAF and civil air traffic controls.



Part of the large Intermediate Distribution Frame through which all the complex types of equipment in the system are interconnected.

Block schematic of the automatic keyboard system.



The television control room at the Post Office Tower

The Post Office plays a vital role in the transmission of television to the nation. This article traces the huge advances that have been made in the past 21 years.

21
YEARS OF NETWORK TV

A J Sudbery

IT IS now taken for granted that television programmes can be seen in almost every town and hamlet in the United Kingdom. Yet it is only 21 years since the first TV broadcast was seen outside a comparatively small area around London, and the vital part the Post Office has played in helping national television to come of age may not be appreciated by many people.

The first inter-city programme on December 17 1949 was broadcast from the BBC Headquarters at Alexandra Palace and transmitted by the Post Office to the Midlands through aerials at the former Museum exchange building in London and Telephone House, Birmingham. The transmission was controlled by a few technicians working in small rooms at the Museum and Birmingham exchanges. From that modest start has grown a network covering the whole country, with the Post Office Tower in London as its hub, taking in world-wide TV transmissions via satellite and Eurovision.

Television was restricted to people living within a 30-mile radius from London—the range of the Alexandra Palace transmitter—when broadcasting was resumed after World War II. By 1947, when it was decided to extend transmissions to the provinces, advanced communications systems resulting from wartime work made it possible to consider economic methods of transmitting television over greater distances. The job of the Post Office was, and is, to carry all signals travelling from point to point. The programmes originated by a broadcasting company are fed into the Post Office national network and carried to regional transmitters. The responsibility for sending the signals from these transmitters to the television set in the home reverts to the broadcasting company.

Designing a transmission system that could cope with the complex nature of TV signals created completely new problems. There was limited experience anywhere in the world to draw upon, either technical

or economical, and in those early years it was uncertain whether coaxial cable or radio links would be the best answer. To provide a basis for comparison, two schemes were engineered: one used a specially designed one-inch diameter coaxial cable and the other a short-wave radio link. Both systems paved the way for a new technology.

The radio link between London and the Midlands worked at a carrier frequency of 900 MHz. It was a frequency modulated system—and the output was from a disc seal triode valve. The aerial feed was coaxial cable and not a waveguide, and there were four intermediate amplifying stations along the route. The local feed from the BBC studios to the transmitter at Museum exchange and between Telephone House and the Sutton Coldfield aerial was the new one-inch coaxial cable. There was only one transmission path and to enable pictures to be received and transmitted the link was made reversible by means of mechanical switches in the aerial feeders and in the amplifier stations controlled from London.

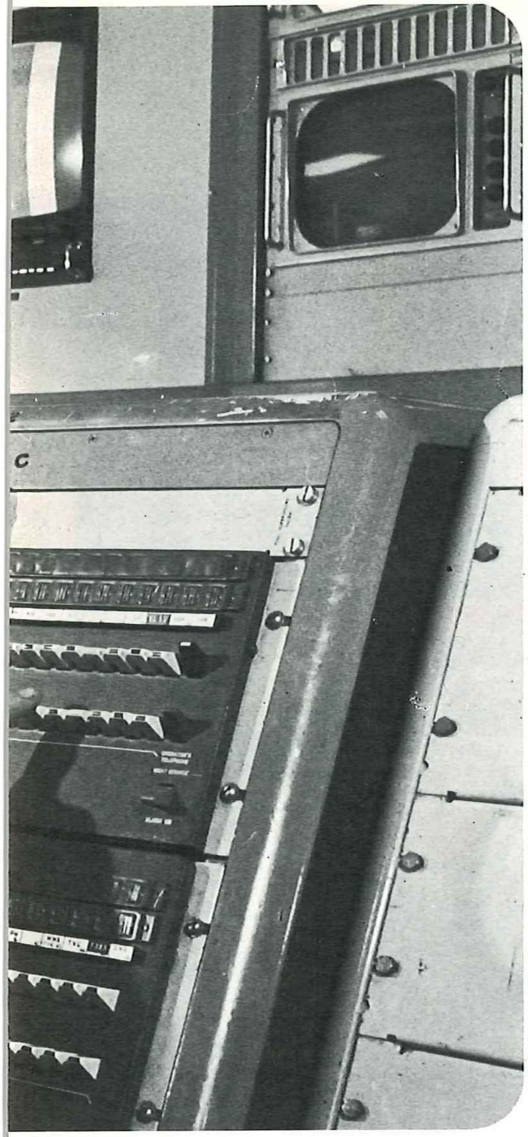
The coaxial cable link to the Midlands opened in 1950 and this was used while the experience gained in radio transmission was assessed and modifications made. The cable worked at a carrier frequency of 6.12 MHz and was amplified and equalised every 12 miles. During the early fifties the system expanded: vestigial sideband links operating at a carrier frequency of about one MHz over three-eighth inch coaxial cables were opened to the West Country, and radio links to the Isle of Wight and Norwich at 2 GHz. The service spread northward to Manchester, Scotland and eventually all parts of the country. As a result of developments in radio and solid-state circuitry, microwave radio is now proved to be the most economic method of transmission and is used for all new parts of the network.

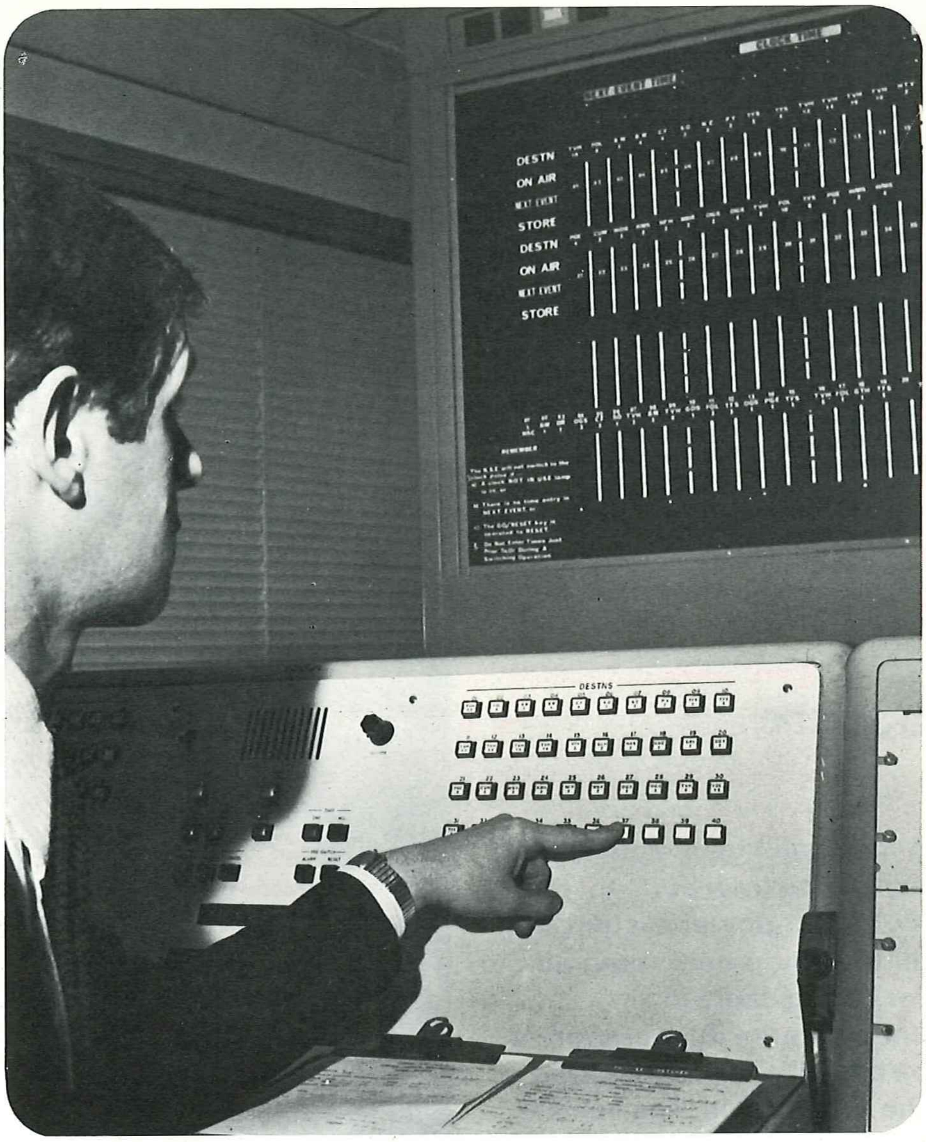
Above: an operator monitors the quality of BBC and ITV pictures transmitted from the Post Office Tower in London.

Right: at this network switching console programmes from the various ITV studios are switched to the required transmitter. The equipment can store two programme switches in advance, and these are shown on the display board.

In 1956 the advent of commercial television required the duplication of the whole main line system, and brought a new dimension to Post Office activities in the TV field. The regional television companies set up to provide the service had to send programmes to the network which could be broadcast from transmitters in other parts of the country: this necessitated the introduction of switching arrangements in the commercial network. Network Switching Centres, with connexions to the programme company studios were set up in the Post Office Repeater Stations at the focal points of the network.

At first manually operated switches were used—and the operators had an alarm clock to remind them when a switch was due. Today there is automatic switching at the five major Network Switching Centres—London, Birmingham, Manchester, Carlisle and Kirk o' Shotts in Scotland. The switch is carried out by an electronic clock synchronised with the Post Office Speaking Clock, and two programmes can be set up in advance and stored in the switcher's memory. In London as many as 30 programme sources can be switched





to any or all of 40 destinations. At the other four centres 15 programmes can be switched to any or all of 15 destinations.

There are now 15 TV Network Switching Centres operated by the Post Office in all parts of the country. An important part of Post Office responsibility is to ensure the quality of the picture transmitted is not degraded: the aim is to accept the signal from the broadcasting company and to send it to the transmitting aerial without noticeable distortion along the line. This is no easy task when the complex wave form of the signal is considered.

Another aspect of the work is the provision of temporary links requested by the broadcasting companies, for example feeding an outside broadcast into the network. International links have become more frequent in recent years and the "picture by satellite" caption is often seen on the screens. The Post Office is responsible for maintaining the link with Europe through its Tolsford Hill radio station and from the Goonhilly Earth Station comes programme material from every continent of the world.

In the last few years the Post Office has been involved in a huge effort to provide facilities for UHF 625-line transmission which made possible the extension of colour television to all three channels. The simultaneous broadcast of programmes in both 405-line VHF and 625-line UHF, necessary to prevent millions of VHF sets becoming useless, has created an enormous problem. The solution required the upgrading of the existing 405-line network of Post Office main, transmitter and studio links. (This aspect was described in an article in the Winter 1969 issue of Telecommunications Journal.)

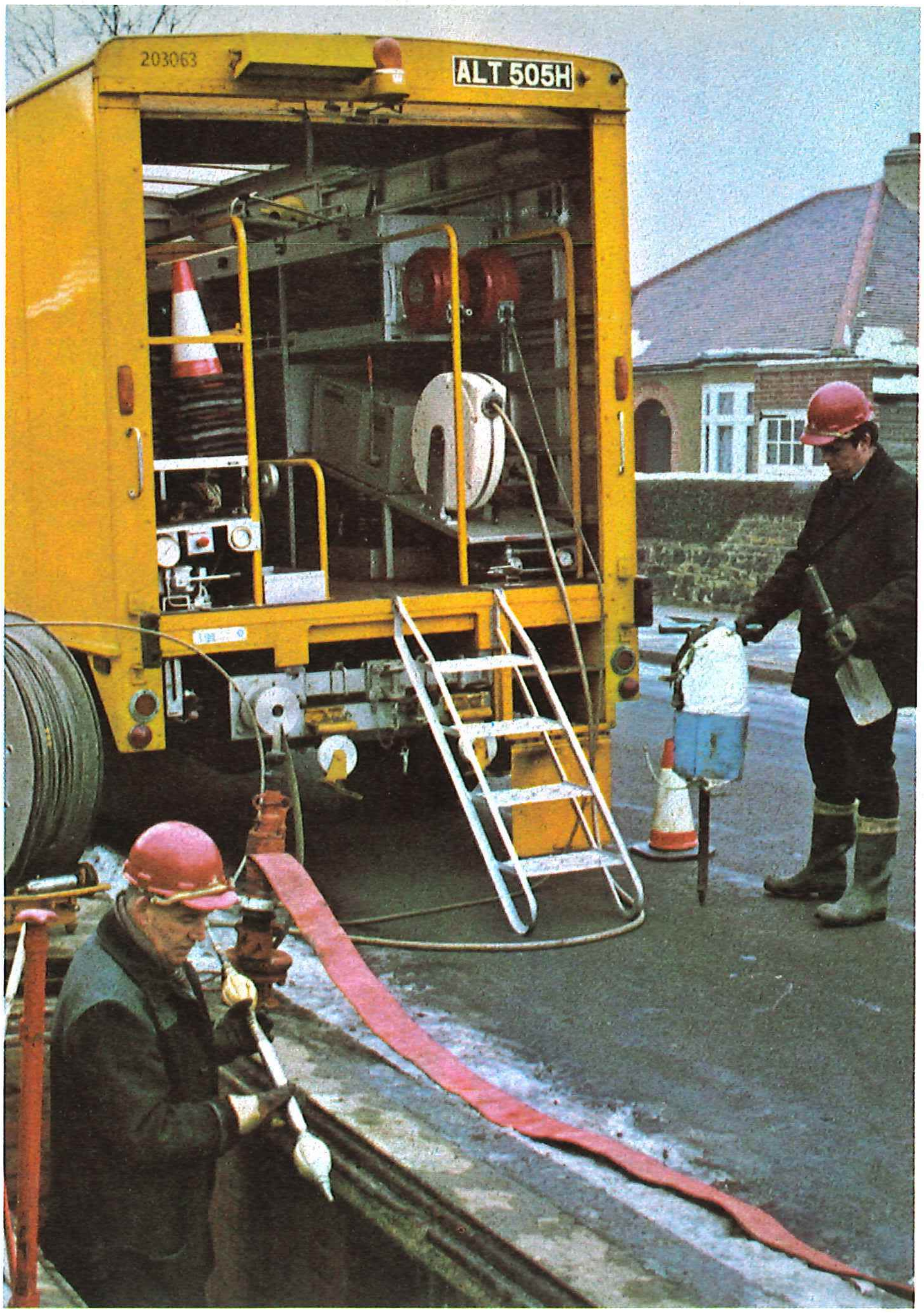
The network is now one of the largest and most advanced communications complexes in Europe, using 7,000 miles of main-line links with a reliability rate of 99.98 per cent. The system has been frequently studied and emulated by broadcasting administrations in every part of the world.

Mr. A. J. Sudbery, the author, on the aerial gallery of the Post Office Tower (right). He was involved in the very first television transmission outside London 21 years ago, and is now Executive Engineer with responsibility for the telephony and television transmission at the Post Office Tower.

The all in one vehicle

S J Little

A new cabling vehicle which carries its own built-in hydraulic-power system and all the equipment required for laying cable in underground duct is soon to be brought into service by the Post Office. The vehicle and a lightweight cable-drum trailer will enable only two men to prepare ducts for heavy cabling and install cable of up to 45 mm. in diameter and 1,000 lb. It will eventually be used in every telephone area.



A two-man crew test part of the vehicle's equipment—a ductmotor (left) and roadbreaker (right). Compressed air to power the equipment runs from lines at the rear of the vehicle. The red hose runs from the water pump.

EXTERNAL cabling has come a long way from the days when a gang of six men or more had to push cane rods, like the old-fashioned sweeps rods, through a duct and use them to pull in a light line which in turn was used to haul in a cabling rope. And it was all done by muscle power. The only mechanical aid was a winch to help draw in the cable itself, and it was slow, laborious and dirty work.

Over the years much effort and inventiveness has been devoted to improving cabling methods. There has been a constant striving towards improving the technical efficiency of cabling plant, to increasing the effectiveness of the equipment used and, not least, to achieving a better use of the work force involved.

One of the most noteworthy developments was the ductmotor. A pneumatically operated machine, it propels itself through a duct and pulls in a draw rope without the need to push through rods. As an alternative to the ductmotor, manual and power operated methods have been devised to push a continuous steel rod through a duct, this rod, in turn, being used to pull in a draw rope.

Better use of the work force was achieved by the introduction of specialised parties. For instance, it was found that two men could prepare a duct for cabling by clearing it of obstructions and inserting a draw rope. These men were followed by a four-man unit whose sole duty was to pull in the cabling rope and draw in the cable. It was also found that appreciable lengths of polythene-insulated and sheathed cable having up to 100 pairs of conductors could be drawn in by a two-man party using the continuous steel rod and a simple power-driven "mangle" like unit which pushed the rod into and withdrew it from a duct.

It was when improvements in the utilisation of powered equipment were investigated that the idea of a centralised power-supply evolved. The major aim was a reduction in the setting-up and closing-down times at the work site. Most of the conventional equipment—the trailer-mounted winch, air compressors, water pump and electric generators—had its own power supply which in many cases had to be unloaded from the cabling vehicle and connected up before the plant could be used.

What was required was a source of power, driven preferably by the vehicle engine, which could supply energy to the equipment used by a gang and enable it to be operated with the minimum of time necessary for loading, setting-up, closing-down and reloading.

The answer has come with the development of a vehicle equipped with a centralised power-supply and the basic facilities regarded as essential for a cabling team. These consist of a rod pusher, specially developed to allow the vehicle to use a one-inch-diameter plastic rod now ousting the continuous steel rod, a storage reel for the rod, a winch, a water pump for clearing flooded manholes, a road breaker and ductmotors.

The power to drive this equipment comes from an hydraulic pump driven by the vehicle engine. This pump drives hydraulic motors which in turn powers the rod pusher, the winch and two air compressors, the latter supplying compressed air for the road breaker, ductmotors and water pump through air lines mounted on automatically-retracting reels.

The vehicle also carries road-guarding equipment, plastic sectionalised hand-rods which have superseded the old cane rods, a manhole-cover lifter and the variety of small tools and stores needed during cabling. Even a propane-gas ring has been provided to enable the crew to boil water or heat food. Two way radio communication has also been provided to enable the crew to keep in contact with one another when they are working at either end of a duct.

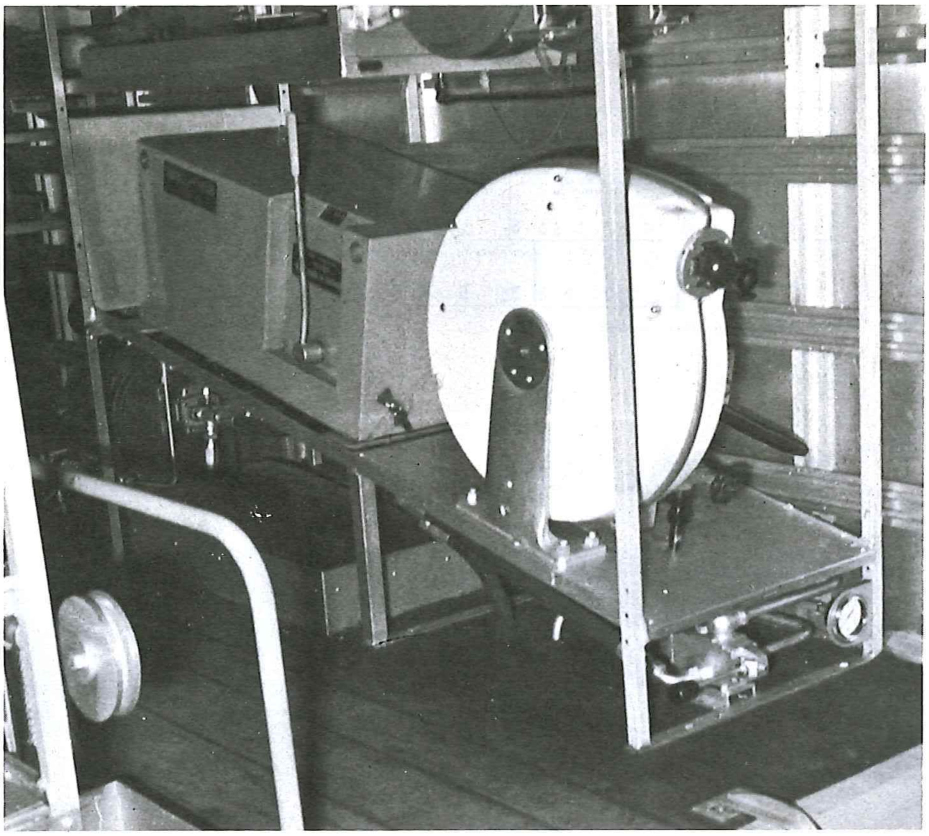
Cable to be laid by the new unit is automatically re-reeled in the stores from standard cable drums onto special lightweight drums which the vehicle takes out to site on a lightweight trailer.

The specially developed rod pusher consists of a pair of caterpillar tracks mounted one above the other which grip the rod and push it into or withdraw it from a duct by the simple operation of a control lever.

Studies undertaken during trials of prototypes have shown that about 240 vehicles, each with a two-man crew, will be capable of dealing with 80 per cent of the national annual cabling load and that the return on the capital invested will be well above the current stipulated figure of 10 per cent.

Deliveries of the new vehicle are programmed to begin in March and should be completed by the end of this year by which time they will be operating in every Telephone Area in the country.

Mr. S. J. Little who is Assistant Staff Engineer in charge of mechanical engineering in Civil and Mechanical Engineering Branch of Telecommunications Development Department, was closely involved with the development of the new vehicle.



This section of the vehicle shows the rodding machine (with control lever). The rod can be seen emerging from behind a reel which holds a compressed-air line.

NEW TEC AT FOLKESTONE

A NEW Telephone Engineering Centre at Folkestone and another nearing completion at Thanet are being assessed by the Post Office as part of a study which should lead to improved designs for future TECs.

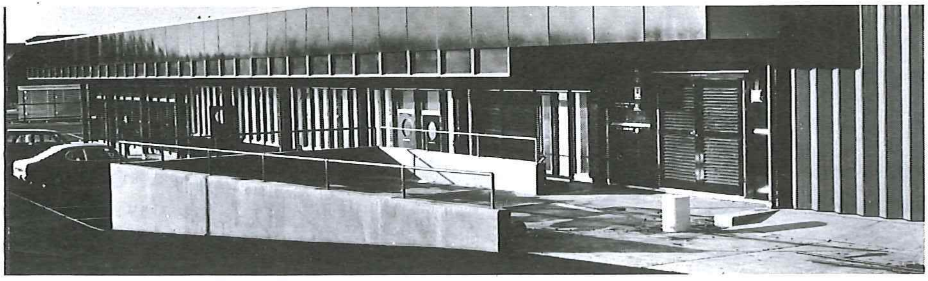
At Folkestone the new TEC (below) has been designed and built to enable personnel, materials, equipment and transport to move through the Centre quickly and efficiently, especially during the peak periods—in the mornings when staff arrive to pick up vehicles and equipment and on their return at the end of the working day.

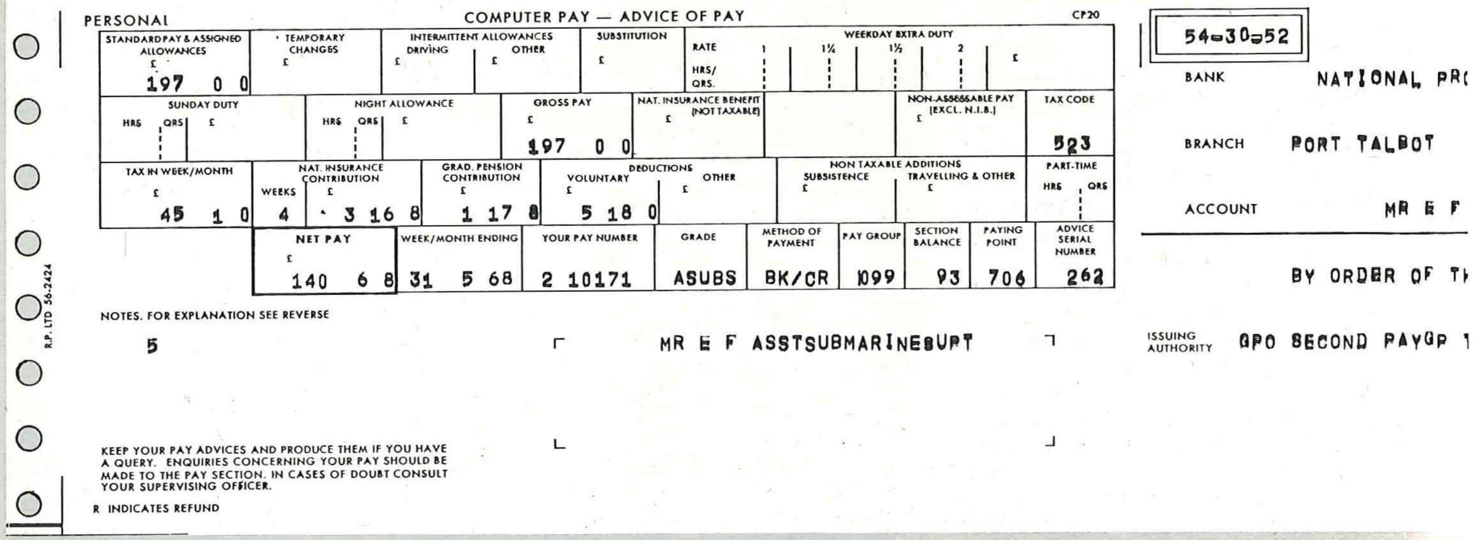
All covered accommodation is under one roof in the centre of the site, where a compact single-storey building with uniform roof height allows flexibility in the use of internal space. A one-way traffic system encircles the building with fuelling, vehicle-washing and other open-air services strategically placed around this circuit to allow vehicles to progress from one to the other with ease.

Within the main building a central assembly room gives easy access to the offices, workrooms, welfare facilities and stores-issue counter which are grouped around it, and to the parking areas around the building. Stores and motor-vehicle workshops are at each end of the building where "straight-line" extensions can be added if required.

The exterior of the building is predominantly black, relieved by doors and window frames in hunting scarlet.

The Folkestone building was designed by architects Austin-Smith Lord of London in association with the Joint Post Office/Department of the Environment Telecommunications Accommodation, Research and Development Group.




PERSONAL

COMPUTER PAY — ADVICE OF PAY

CP20

STANDARD PAY & ASSIGNED ALLOWANCES £: 197 0 0
TEMPORARY CHANGES £:
INTERMITTENT ALLOWANCES DRIVING £: OTHER £:
SUBSTITUTION £:
WEEKDAY EXTRA DUTY RATE 1 1¼ 1½ 2 HRS/QRS. £:
SUNDAY DUTY HRS QRS £:
NIGHT ALLOWANCE HRS QRS £:
GROSS PAY £: 197 0 0
NAT. INSURANCE BENEFIT (NOT TAXABLE) £:
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TAX CODE: 523
TAX IN WEEK/MONTH £: 45 1 0
NAT. INSURANCE CONTRIBUTION WEEKS: 4 £: · 3 16 8
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WEEK/MONTH ENDING: 31 5 68
YOUR PAY NUMBER: 2 10171
GRADE: ASUBS
METHOD OF PAYMENT: BK/CR
PAY GROUP: 1099
SECTION BALANCE: 93
PAYING POINT: 706
ADVICE SERIAL NUMBER: 262

NOTES. FOR EXPLANATION SEE REVERSE

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MR E F ASSTSUBMARINESUPT

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ISSUING AUTHORITY GPO SECOND PAYGP

A specimen payslip with details printed by the computer - before D-day - together with the advice to the payee's bank.

YOUR PAY BY COMPUTER

D Pruce

BY THE end of this year most telecommunications employees in the Post Office—both weekly and monthly paid—will have their pay processed by computer. The new Computer Payroll system which will make this possible has already been introduced in a number of Telephone Areas and is being extended on an agreed implementation plan throughout the Telecommunications business with the exception of Northern Ireland, Eastern Region and Wales and the Marches. By the end of 1971 the pay of 140,000 weekly and 60,000 monthly paid staff will be calculated by computer. Eastern Region and Wales may eventually come into the plan. The implementation plan for the postal business has not yet been finalised, apart from London offices.

The Computer Payroll system has been designed to pay all grades (282 of them) except industrial and cableship staff, and will be processed on ICL 326 computers in London, Edinburgh, Derby, Portsmouth, Bristol and possibly Cardiff. These centres will also take care of the conversion of the pay information prepared in Pay Groups into punched card form.

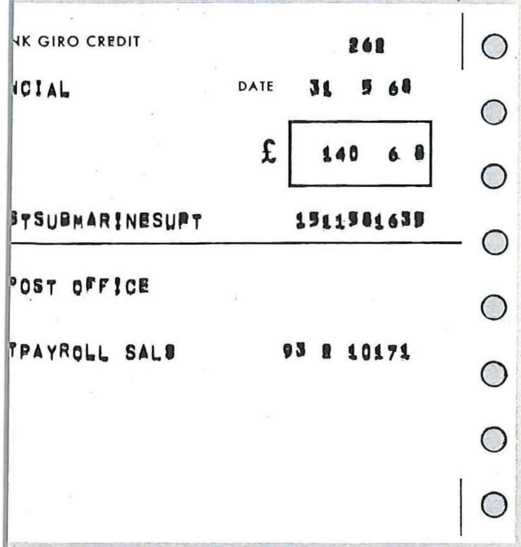
The pay-slip which is printed by the computer has been designed to give as much information as possible to staff, and the system has demonstrated during trials its ability to reduce undetected errors of calculation almost to vanishing point.

For pay clerks, the tedium of preparing manual or accounting payrolls is removed. The preparation of payroll input for the computer has still to be done but overtime, for example, is submitted in hours and quarter hours and the computer takes care of the calculations. In addition, the input sheets are pre-printed by the computer with payees' names in alphabetical order, and the payroll input includes accounting sheets which amount to what is virtually a balanced payroll. The system offers a number of advantages to management, including analyses of grades and heads of expenditure, accounting totals, and the opportunity to review Pay Group staffing and to divert staff saved to other work. Under development are the extraction of various management statistics from the results of payroll processing, and these are a growing and extremely interesting side-issue. For example, the allocation of a job code to every payee enables the actual cost of various activities, or sub-levels of activity, to be analysed every month in a combined statement of costs for wage-earning and salary-earning staff.

The design of the Computer Payroll system involved the writing of 29 Systems Specifications which define, in precise detail, what the system must perform; the necessary Program Specifications which detail how the system shall be enabled to produce the required results, and from these the Programs—the actual instructions which enable the computer to perform the required actions step by step, and a great deal of instructional material.

The project team was involved, with Training Divisions, in the preparation of material for Programmed Learning instructions, and in the training of some Task Force Leaders and members. Programmed Learning enabled training to be arranged in local offices and avoided the need to send pay clerks to central schools.

The system was under trial for nine months before being used in the field. The trials preparation and checking was done by Task Force staff on whom so much responsibility rests for successful conversion and implementation. They involved the creation of a



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Staff in East Area TMO Pay Group prepare payroll input sheets for the computer. They enter up such details as overtime hours worked, but all the subsequent calculations are done by computer.

dummy payroll embracing all ranks and grades and its subjection to changes and additions which would rarely, if ever, be met in combination in live working.

The trials were, in fact, a threefold attack on the system. There were "positive" trials, to prove that input correctly submitted was correctly processed. There were "negative" trials, to prove that input which was outside the limits set for particular items (for example 24 hours Sunday duty, 80 hours weekday overtime, 12 days increment for weekly paid staff) or contravened validity checks (for example, overtime submitted for a non-overtime grade), was rejected and reported on the exceptions report. The third set of trials were to ensure that the built in safeguards in the computer system which warn the computer operators that, for example, internal proof balances have failed, were operating correctly. These were the most difficult. Obviously, if the system is functioning correctly the warning system is never invoked, and it was necessary to corrupt details to ensure that the warnings were brought into operation.

The monitoring system for the control of trials which enabled us to trace progression from one trial to another and also to relate the effect of a fault in one part of the program to other parts was complex, but it enabled us to offer proof of successful trials at all stages to the "customer"—Telecommunications Finance Division, who have acted throughout on behalf of and in co-operation with PHQ, THQ and CHQ, as the "sole customer".

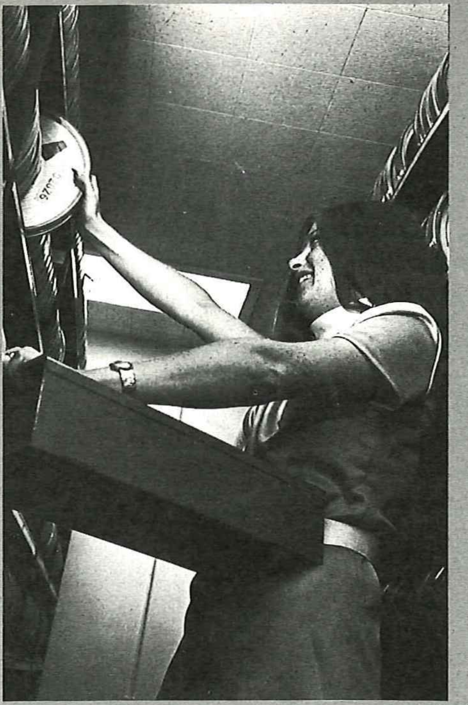
Pay Groups are being added to the system by Task Forces under Regional control but working to an implementation plan agreed by the Region with THQ/MSD and the appropriate Computer Centre Manager. Task Forces have been trained in implementation and in computer payroll. They will move from office to office in accordance with the implementation plan for their Regions to give local office training and assistance to staff in the early days of conversion.

After a Pay Group has been added to the Computer Payroll system, pay information (overtime, Sunday duty, increments, etc) will be entered by local office staff on punching documents for punching and processing, and most calculations of overtime, part period increments, etc will be automatically calculated by the computer.

Normal payroll processing will produce all the documents required for payment, including pay advices, proof sheets (office copies of pay advices), Giro cheques, Giro transfers, Giro listings, schedule of pay changes, schedule of voluntary deduction changes, bankers credit transfers, bankers credit listings by banks with totals, pre-printed input sheets for future input accounting totals.

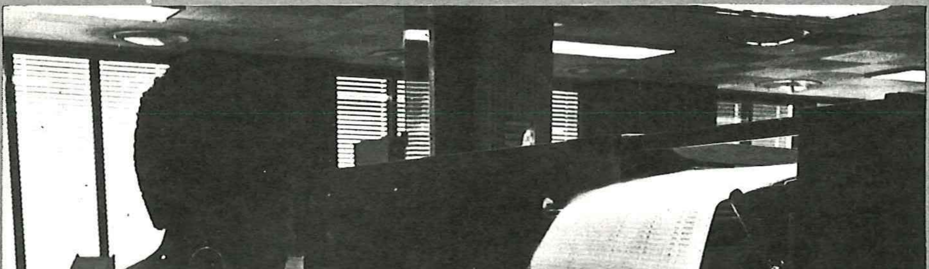
In addition, the system performs other miscellaneous jobs, for example current pay revisions; production of end-of-the-year tax certificates and listings; issue of quarterly individual pay records showing earnings by categories for the previous quarter; automatic issue of up-to-date individual pay records whenever a payee's basic data changes.

The time-scale for weekly processing is a tight one. Pay information needs to be prepared and despatched by Pay Groups on Mondays, punched and processed by Computer Centres and returned to Pay Groups by Wednesday mornings, and it is recognised that for pay clerks the time-scale imposed by the need to get input to computer centres on time is more



A magnetic tape containing information supplied by pay groups is taken from the computer centre library.

A machine operator checks payroll proofsheets which go back to the appropriate Pay Groups to provide them with pay details and accounting totals.



rigid than that for manual or accounting machine payrolls.

Some idea of the complexity of the Post Office payroll can be gained from the fact that there are 15 programs in the main suite, with a total of 29,200 program instructions; there are 282 grades, with both wages and salaries to be catered for; there are 14 ways of paying weekday overtime and six ways of paying Sunday duty; staff are paid by cash, by Bankers Credit, by Giro Transfer and by Girocheque; and that since 1st January 1970, when implementation began, some 94 pay revisions and amendments to grade conditions have been dealt with. The system has been converted for decimalisation and modified to provide for superannuation.

Although Post Office computer payroll may be new to provincial staff, it is not new to London staff, who have been paid by the LEAPS computers since 1959. It is perhaps appropriate here to say farewell to the LEAPS installation which was switched off on 31st January 1971 for the last time. The birth of LEAPS was an act of courage in the mid-50s, when computers were in their infancy. Every aspect of the project was a step into the unknown—the choice of computer, the choice of printer, the method of input (whether punched cards or paper-tape) the design of input forms and the use of Task Forces. The installation has carried a load of some 48,000 wages and 42,000 salaries for 12 years, together with a number of additional jobs which have been fitted in round the payroll timetable. It has been a nursery of ideas on which much has been built and from which a great deal has been learnt.

Mr. D. Pruce, a Senior Executive Officer in Post Office Data Processing Service, is Project Leader for the Computer Payroll system. He was involved in the early planning of the system and the subsequent systems design and testing. He was formerly a Task Force Leader for the LEAPS installation.

THE LAST OF LEAPS

AT THE end of their working life the two veteran computers which pioneered the Post Office computerised payroll system in the 1950s have been spared from the electronic scrapheap. The National Elliott 405s, now overtaken by the rapid obsolescence of computer hardware, have been given away by the Post Office to the Bolton College of Technology. There they will end their days as a technological kit for students.

The computers and associated equipment formed the LEAPS installation—the London Electronic Agency for Pay and Statistics—which handled its first live traffic in 1959 after a huge programming task. It was then one of the world's largest centralised payroll computer systems, and the planners were not able to draw upon any experience elsewhere of work on the same scale.

Until the beginning of this year the LEAPS installation, at Armour House in London, processed five million pay transactions annually. These included salary and wages for national-headquarters staff and the London Telecommunications and Postal Regions, and pensions for all the Post Office's retired staff.

The system was also used to produce management statistics—including telephone service observations and exchange line costs—to carry out research for the Post Office and universities and to process financial settlements with overseas administrations.

At a ceremony to mark the handing over of the computers, Mr. F. J. M. Laver, Board Member for Data Processing, said the two "veterans of the valve age" had served the Post Office with distinction. "I am happy to think they will continue to give valuable service in Bolton, helping to train future programmers and electronic engineers," he added.

The computers themselves had the final say. The last act of LEAPS 405 No 1 was to print out a farewell message to the Post Office and to play a medley of electronic music ending, inevitably, with Auld Lang Syne.

A new cable-laying machine which allows submarine cable to be laid faster and more efficiently has been developed by Post Office Research Department for Marine Branch

'straight-line' machine speeds cabling

D N Dick/C J Clarke

THE methods and machines used for laying submarine cable have developed over the years to meet the limitations of new types of cable construction and the introduction of repeater systems.

Cables were originally laid using a large capstan drum round which the cable was turned to provide a grip with a simple "back-tensioning" device to maintain that grip. The drum was controlled either by a driving motor or a braking system. The first departure from the simple drum-method was necessitated by the development of repeatered telephone cable systems. To lay such systems with the conventional drum would involve the removal of turns from the drum, by-passing the repeaters and re-installing the turns. It was a laborious and time-consuming process.

In the early 1950s the Post Office developed the "five-sheave" gear to simplify the by-pass procedure and allow a continuous process, though the repeaters were passed by the machine at a speed restricted to a maximum of two knots. The five sheaves were in line fore and aft and the cable followed an "under-and-over" path.

At about the time that the deep-sea repeater was introduced a new type of deep-sea cable was being developed of the now familiar lightweight construction. It became evident that bending of this cable during handling and laying, as with the five-sheave gear, could seriously impair its working life. A straight-line method was required which would minimise this flexing.

The earlier linear machines envisaged were based on rubber-tyred wheels suitably loaded to grip the cable. At the time, rather complicated means of braking and driving a large number of such pairs of wheels would have been necessary.

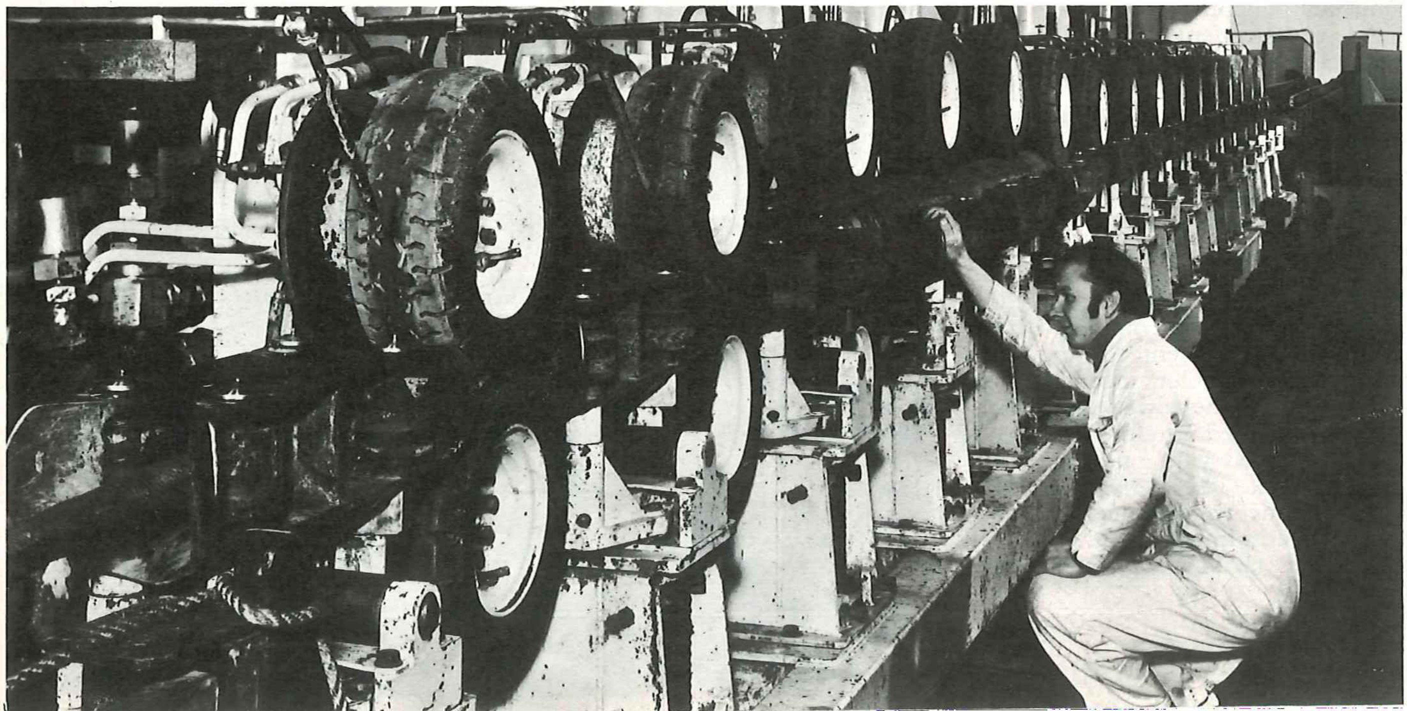
More recently, the application of this principle was again investigated, initially with a view to producing a more efficient cable-transporter for use in depots. This resulted in the production of a small machine comprising a single pair of pneumatic-tyred wheels driven through a mechanical reduction drive from an electric motor. The upper wheel was carried on a pivotal arm, the clamping pressure being produced by a hydraulic ram applied to the arm. It was found that such a pair of wheels could produce a cable pull in excess of 1,000 lbs on armoured cable. This pull was limited to 1,000 lbs on lightweight cable, this being considered the maximum before inter-layer slip occurred between the outer sheath and the inner members of the cable.

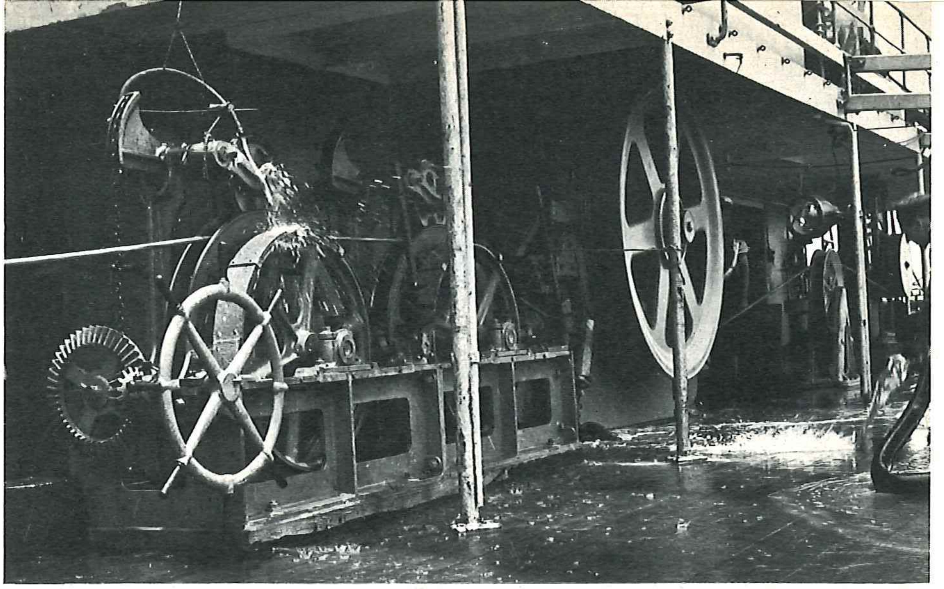
At this time an hydraulic motor was being developed by the National Engineering Laboratory at East Kilbride in Scotland. Known as the "Ball Motor", one possible application was to provide an hydraulic drive to road vehicles by mounting this motor within the hub of the road wheels. This form of drive presented the possibility of a relatively simple means of driving a number of pairs of wheels to produce a linear machine for a ship with a laying capability.

A design was then developed comprising four pairs of wheels. The wheels in each pair were mounted one above the other and carried on pivotal arms so coupled that they opened symmetrically about the cable line. This design it was found would sustain a cable load of up to two tons and could "swallow" a rigid repeater, hydraulic clamping arrangements being so designed as to maintain constant pressure as the wheel pairs opened to admit it.

Two prototypes of this design were built and land tests carried out at the new Post Office Research Station at

The new linear machine which allows both cable and repeaters to pass through in a straight line. In the picture a research engineer on board the Alert checks the after-laying equipment which is fitted below deck. Some of the wheels have opened up to "swallow" a repeater.





The original drum engine around which cable had to be turned. To get repeaters past the drum involved a laborious stop-start process.

Martlesham. The units were operated back-to-back, one hauling against the braking pull of the other. The tests proved that it would be possible, by operating four such units in line, to sustain a cable tension of eight tons and that repeaters could be laid without interruption of cable pay-out—possibly at speeds of up to six knots.

The Martlesham experiments were in fact so successful that it was decided to test the machine under marine conditions on board the Post Office Cableship Alert. It was first applied to the forward cable machinery which is used for handling cable in repair work. This equipment consisted of two motor-driven capstan drums below deck, together with "draw-off/hold-back" gear above deck. The latter is simply a large driven wheel used to provide back-tension to prevent the cable from slipping as it passes around the capstan drum and out over the bows. It has never been very efficient and initially it was intended to replace only this piece of equipment with the new module. But for the purposes of the trials the new machine was made traversable to the ship's centre line, midway between the two engine-driven cable drums below deck. A repeater could be fed through the module, by-passing the capstan and paid out straight over the bows. The repeater was recovered in a similar way showing that this procedure was a practicable alternative in shallow water to the conventional "turns-off-the-drum" operation.

At the same time as the proposals were made to apply these units to the bow machinery, the equipping of CS Alert with a linear cable-laying machine aft in place of the five-sheave gear was investigated. This showed that the necessary performance specifications could be met if four modules of the same basic design as applied to the forward gear were assembled in tandem to produce a machine with 16 pairs of wheels. It was necessary, however, to add some refinements and to modify slightly the physical layout of some components.

An independent braking system was designed as a safeguard against a power failure giving rise to the loss of control of the cable. This system used a disc brake on each wheel, braking effort being exerted by a spring which could be hydraulically retracted. An improved hydraulic motor was used and the layout of the power pack was modified. This power pack comprises electric-motor-driven pumps, control valves, oil coolers and oil tank. On the modified arrangement for the stern gear the oil cooler assembly was separated from the power-pack framework and divided into four assemblies each associated with one module of the machine. These were mounted alongside the engine, and produced an improved piping layout.

Another facility added, not provided on the forward machines, was a system to measure cable tension. The method used was novel and had never been employed before with cable machinery. The complete machine, that is the four modules as one integral unit, was suspended on leaf springs which gave rigid vertical and transverse support. The fore and aft movement of the machine, caused by the varying outboard tension of the cable, was restrained by tension links between the machine and the deck of the ship. Within the tension links were strain gauges which converted pressure energy into electrical energy. This electrical energy was amplified and indicated on meters calibrated as units of cable tension. The amplifier incorporated a device to offset any inaccuracies caused by the pitching movements of the ship.

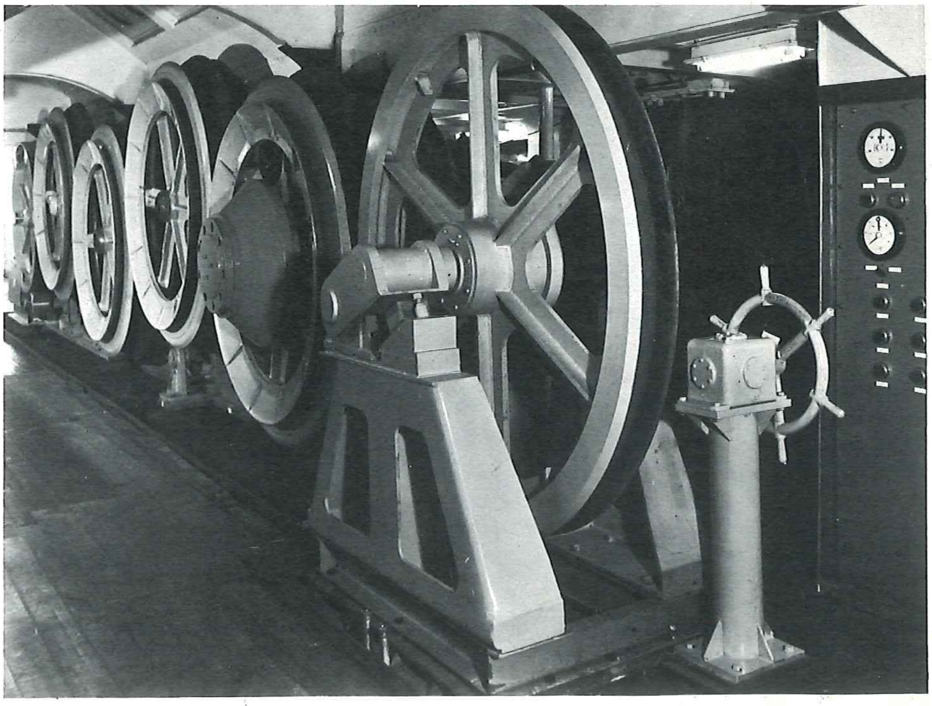
To measure cable speed and length a wheel mounted on a swinging arm on the end of the machine was driven by the cable. In turn this wheel drove by chain a small generator whose output was indicated on a meter calibrated in terms of cable speed. Also driven by the wheel was a counter unit which gave cable length.

The five-sheave gear was removed and the linear machine installed during Alert's 1970 refit and following extensive trials, both shore-based and at sea, the new equipment was recently used successfully to lay the U.K. to Spain cable. The whole system, comprising lightweight and armoured cable and every repeater, was paid out through the machine in two laying operations.

Mr. D. N. Dick, who formerly served as an engineer on board the cableships Iris and Alert is now Superintendent Marine Engineer in charge of marine and mechanical engineering section of Marine Branch at Telecommunications Headquarters.

Mr. C. J. Clarke is an Executive Engineer in Marine Branch with responsibility for mechanical equipment on cableships. He has been involved in the development of both the new linear machine and the five-sheave system.

The five-sheave gear system which superseded the drum method. Cables are bent as they pass under and over the sheaves. Although repeaters still have to by-pass the sheaves a continuous process is possible.



miscellany

Dialling America

TWO MILLION telephone customers in London can now dial their own calls direct to more than 30 major cities in the United States of America. This further step in the Post Office's planned programme for extending International Subscriber Dialling to the USA—introduced on March 1 last year between London and New York City—means that London customers will be able to dial nearly 90 per cent of their trans-Atlantic calls. (About three-quarters of all telephone calls from the United Kingdom to the USA are made from London).

Extensions of ISD from London to the remainder of the USA (excluding Alaska and Hawaii) will be completed within a few months; this is to be followed by the introduction of the service from Birmingham, Liverpool, Manchester, Glasgow and Edinburgh. These centres already have ISD to Europe.

Plans are also in hand to provide the full range of European and USA subscriber-dialling services for customers in other main centres in the UK.

Honours

MR. MURRAY LAVER, Post Office Board member for data processing, was awarded the CBE in the New Year Honours. Mr. Laver became director of National Data Processing Service in 1968 and was appointed to the Post Office Board the following year.

Telecommunications staff honoured are—OBE, Mr. Frederick Haliburton, retired Controller Northern Ireland, who was responsible for maintaining telephone services in the Region during civil disorders; MBE, Mr. George Winterburn, retired Senior Executive Engineer in Telecommunications Headquarters, North Eastern Region; BEM, Mr. Joseph Clarke, who is in charge of kiosk cleaning staff in Manchester, Miss Eleanor Frisk, supervisor of Macclesfield exchange, and Mr. James Heslin, an Edinburgh technician who worked on the communications network for the Commonwealth Games.

Appointment

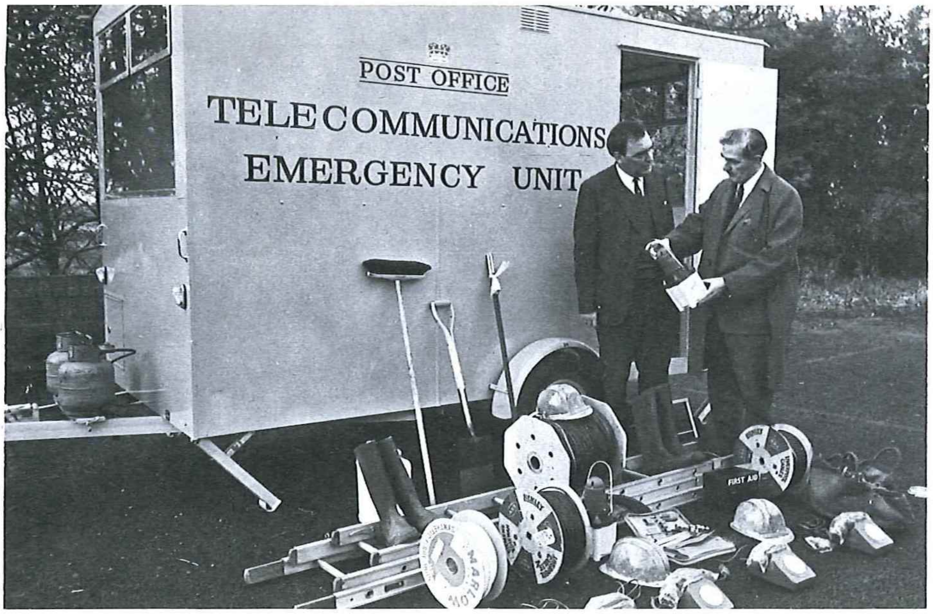
PROFESSOR J. H. H. Merriman, Post Office Board member for Technology, has been appointed to the Television Advisory Committee which has been reconstituted by the Minister of Posts and Telecommunications. The Committee advises the Minister on the technical development of television and sound broadcasting and other related matters he may put to it.

BBC Journal

THE APRIL issue of "BBC Engineering" includes two articles dealing with different aspects of the use of pulse code modulation in broadcasting. "BBC Engineering" is a quarterly publication which has replaced the Corporation's Engineering Monograph series. It includes articles and shorter contributions of interest to engineers in the field of broadcasting and telecommunications. Subscription details can be obtained from BBC Publications, 35 Marylebone High Street, London W1M 4AA.

Four mobile units which provide speedy communication facilities at the scene of emergencies and disasters are in operation in Wales and the Marches. They are described by R. L. Woodhams, a Chief Telecommunications Superintendent at Cardiff

EMERGENCY UNITS FOR WALES



Mr. D. M. Rogers, Service and Marketing Controller in Wales and the Marches (left), examines some of the tools and equipment carried in the units. With him is Superintendent T. O. K. Hicks, Staff Officer to HM Inspector of Constabulary.

THE Post Office operates a widespread and comprehensive communications network for 24 hours each day and people take its presence for granted even in the most remote places and unusual circumstances. The aim is to meet all requirements, even when only short notice is given.

However, natural disasters and major accidents do not give notice, and they frequently occur some distance from the nearest Post Office plant. Indeed, in some disasters the Post Office plant itself may be put out of action along with everything else, and in these circumstances exceptional measures are necessary—particularly to provide initial communications.

The impossibility of predicting when or where emergencies will occur makes adequate contingency planning very difficult indeed. Until now Areas in Wales and the Marches Region have catered for emergencies by strategically locating emergency kits and using specially nominated utility lorries. The emergency kits contain local battery telephones, cable, lights and lamps, electric power source, shovels, ropes, protective clothing and first-aid and emergency food packs, and the lorries are fitted with two-way radio and carry ladders. When not required for emergency purposes the vehicles are used for normal engineering work.

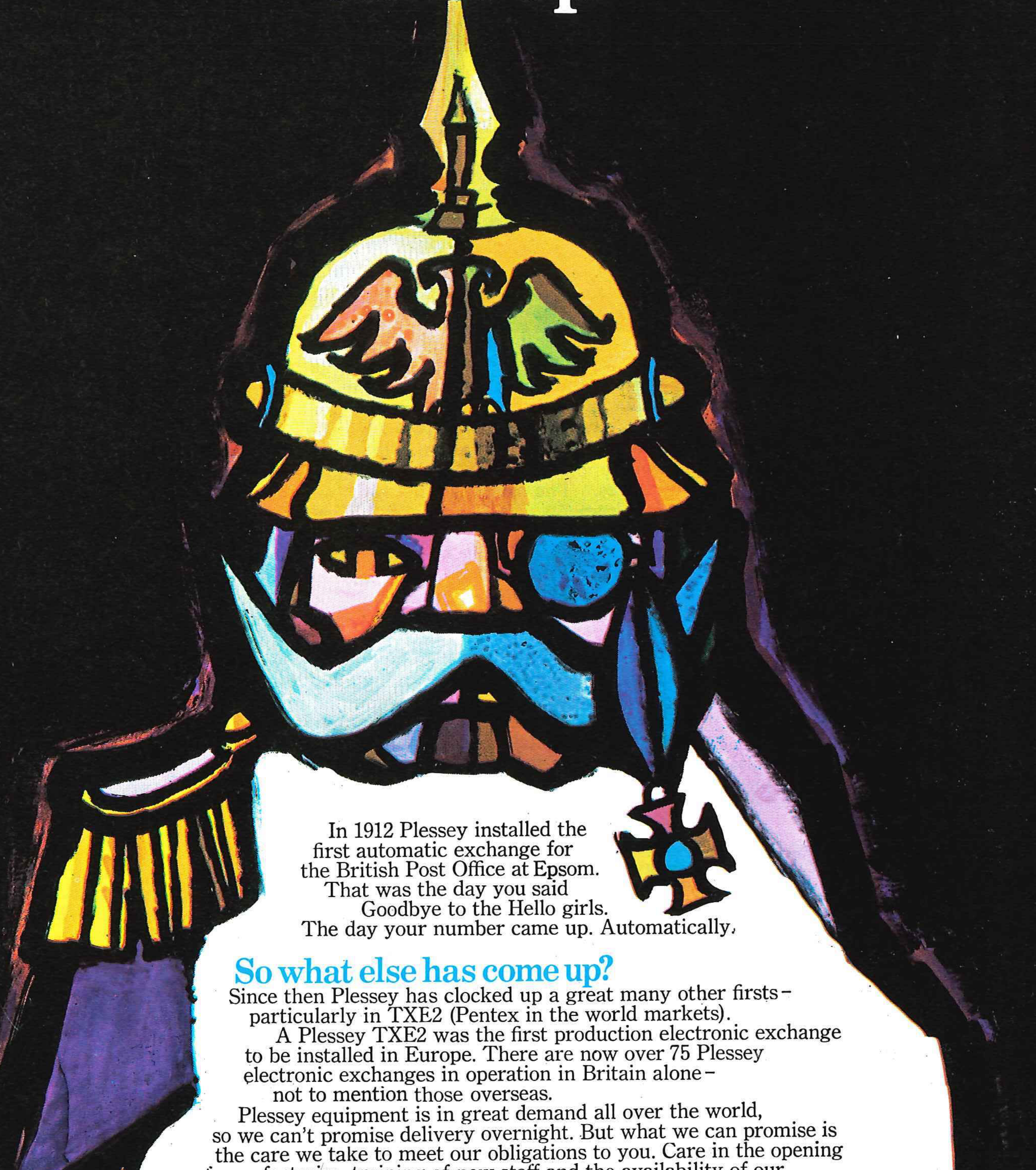
This arrangement has worked very well indeed, but the widespread floods in 1968 and 1969 and the near disaster when the Maerdy dam at the head of the Rhondda Valley was in danger of collapsing last year, led to a review of the Region's requirements. The result is the provision in each Area of a trailer caravan which provides improved facilities, more space and better working conditions.

Each trailer has two-way radio equipment which can be used with any Post Office base radio station in Wales and the Marches. These base stations are usually associated with External Plant Maintenance Controls. The trailers are furnished with sufficient equipment to enable land-line service to be set up to any emergency location, and they allow for telephone facilities to be provided for use by other public services attending the emergency.

Each caravan has washing facilities, and bottled gas powers cooking, heating and lighting. The tools and equipment carried are similar to those in the emergency kits.

The trailers, which were designed in Wales and the Marches and made in Shropshire, are sufficiently lightweight to be able to traverse difficult country and can be towed very close to an emergency location. The towing vehicle will usually be a Landrover, but each Area is also making some of their utility trucks suitable for towing the trailer so as to cater for all contingencies. The cost of each trailer, including full equipment and radio but excluding the towing vehicles, is about £1,000. This is a small price to pay for greater success in handling future emergencies.

1912
-the day your number came up!



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Telecommunications statistics

(Figures rounded to nearest thousand)

	Quarter ended Sept., 1970	Quarter ended June, 1970	Quarter ended Sept., 1969
TELEGRAPH SERVICE			
Inland telegrams (incl. Press, Service and Irish Republic)	2,291,000	2,075,000*	2,335,000
Greetings telegrams	667,000	606,000	658,000
External telegrams:			
Originating U.K. messages	1,999,000	1,887,000	1,948,000
Terminating U.K. messages	1,871,000	1,765,000	1,805,000
Transit messages	1,639,000	1,636,000	1,670,000
TELEPHONE SERVICE			
Inland			
Net demand	256,000	265,000	248,000
Connexions supplied	257,000	279,000	236,000
Outstanding applications	277,000	278,000	242,000
Total working connexions	8,881,000	8,723,000	8,157,000
Shared service connexions (Bus. and Res.)	1,646,000	1,612,000	1,481,000
Total effective inland trunk calls	364,577,000	359,617,000	332,674,000
Effective cheap rate trunk calls	103,341,000	88,175,000	83,562,000
External			
Continental: Outward	4,183,000	3,978,000	3,514,000
Inter-continental: Outward	474,000	518,000*	364,000*
TELEX SERVICE			
Inland			
Total working lines	31,000	30,000	28,000
External			
Originating (U.K. and Irish Republic)	5,857,000	5,843,000*	4,739,000*

**Amended figures.*

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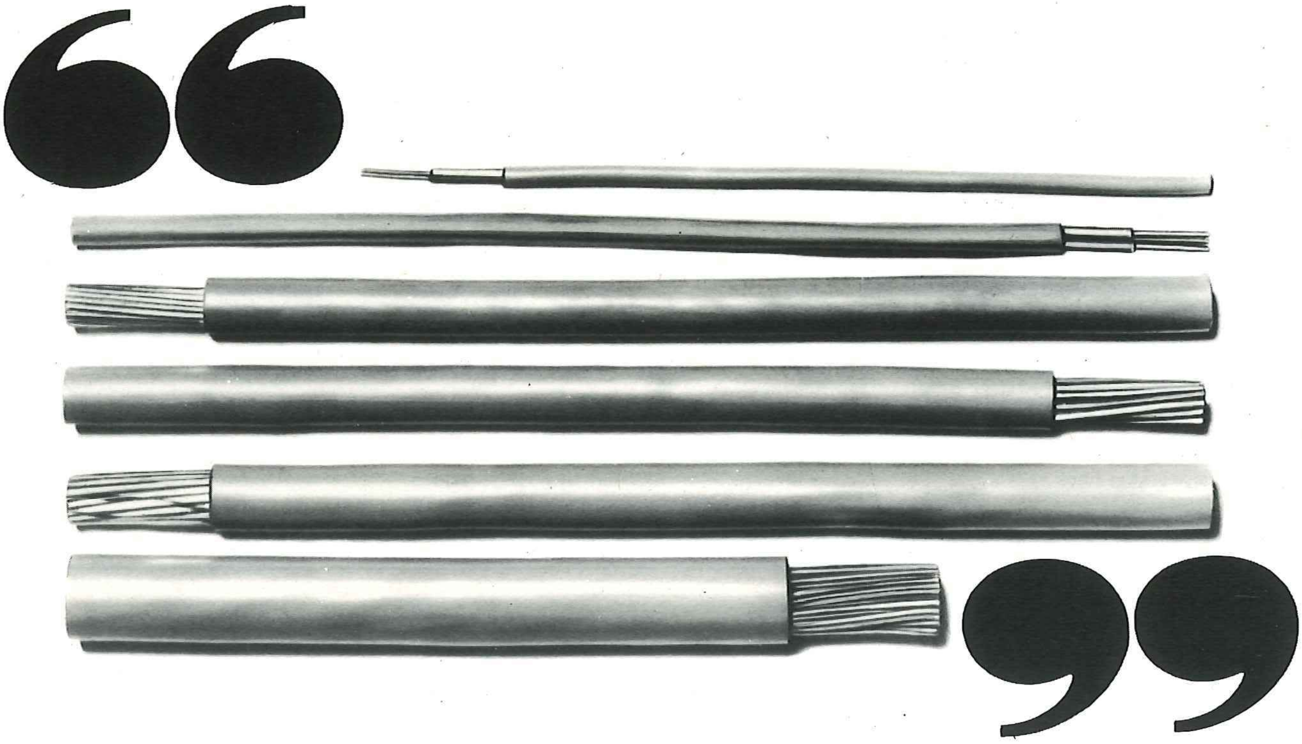

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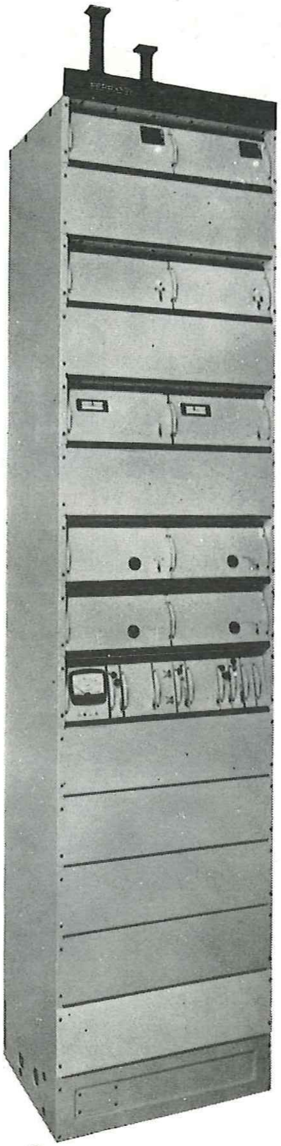

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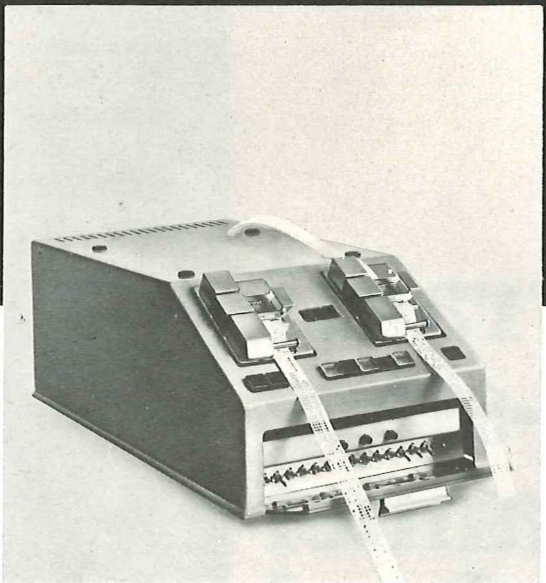
Power Supplies	Mains or Battery operated
Construction Options	British Post Office Type 62 practice. Conventional 19″ rack-mounting. Hermetically sealed units
Environmental Capability	Temperature Range—any 50° in the range −20°C to +50°C. Relative humidity—95%
System Options	
Hot Standby	Single or dual frequency with solid-state automatic changeover at radio frequency, intermediate frequency or baseband as required
Diversity	Frequency and/or space diversity
Repeater Types	Fully demodulating or non-demodulating, with optional drop/insert facilities
Supervisory	Full remote indication/control facilities

CCD 15 rb

Telegraph Tape Transmitting Equipment



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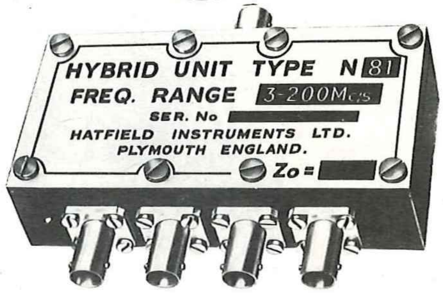

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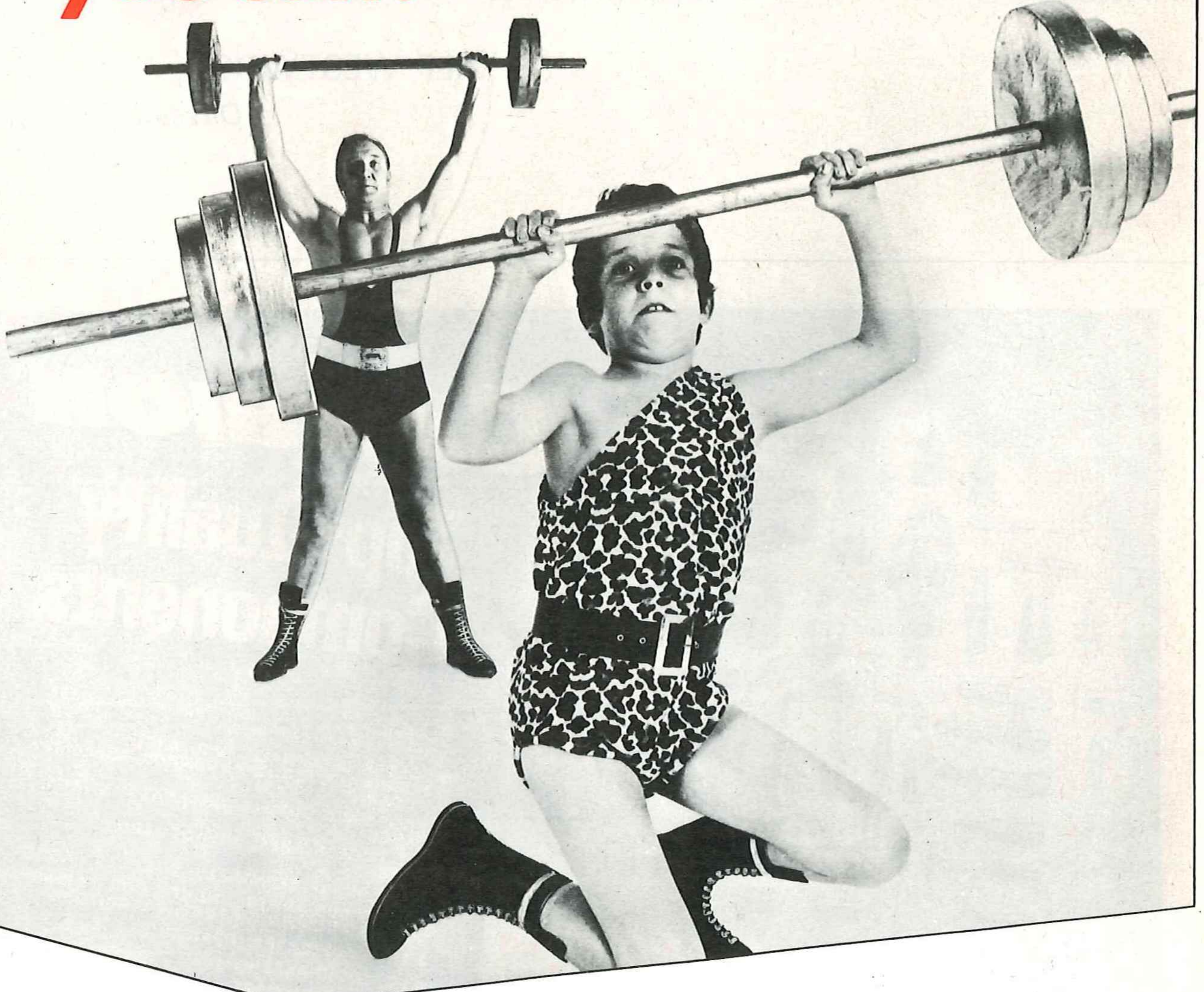

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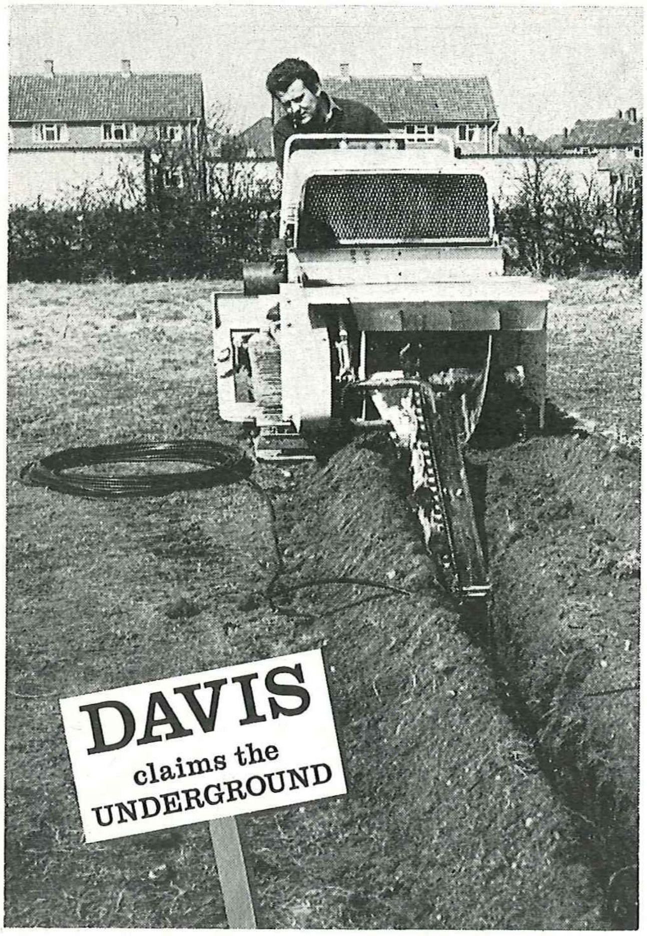

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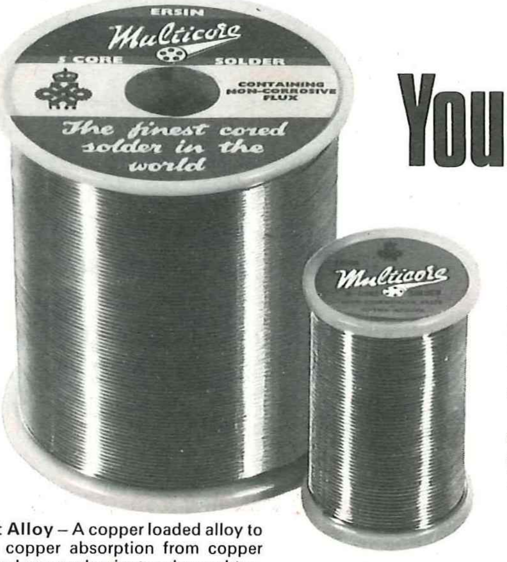
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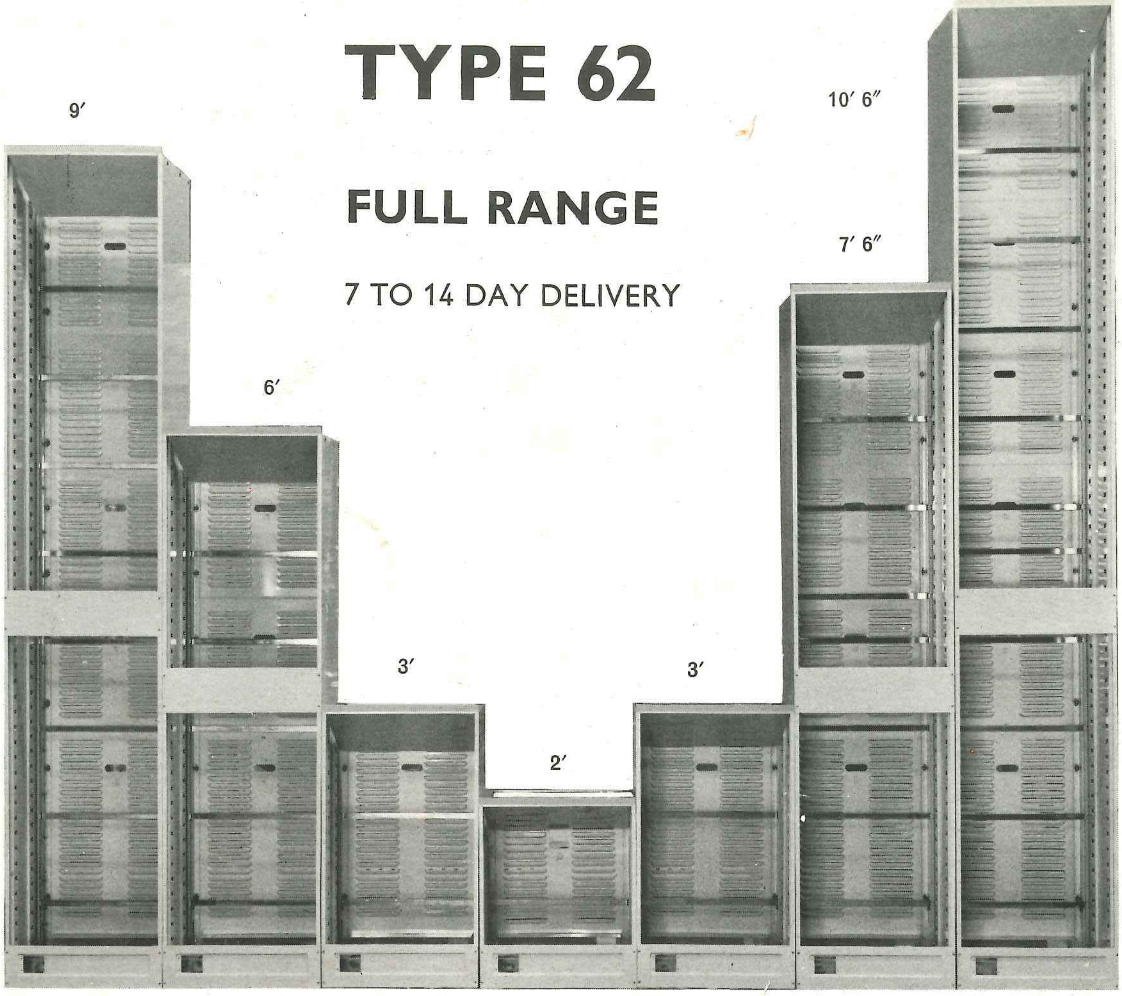

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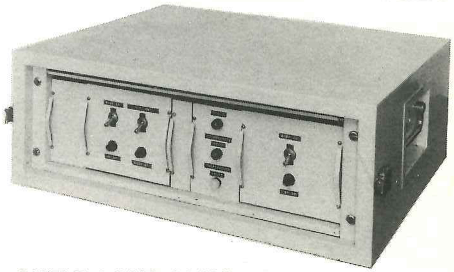

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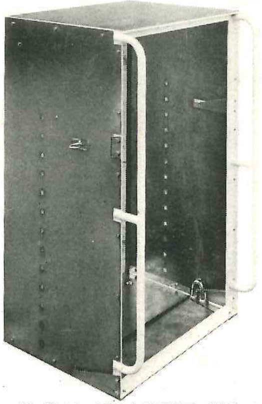

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